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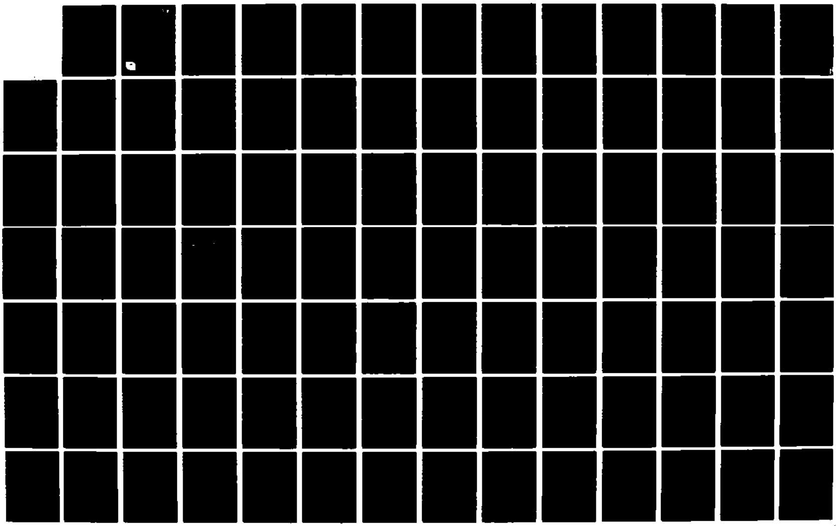

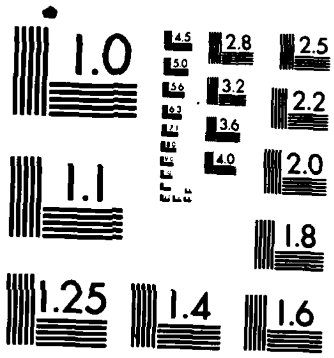

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IDA REPORT R-285

REPORT OF THE JOINT INDUSTRY - DoD TASK FORCE ON COMPUTER AIDED LOGISTIC SUPPORT (CALS)

Volume V: Report of Technical Issues Subgroup

Frederick R. Riddell
Richard A. Gunkel
George Beiser
Siegfried Goldstein
Bruce Lepisto
Editors

June 1985

Prepared for
Assistant Secretary of Defense
Manpower, Installations and Logistics

INSTITUTE FOR DEFENSE ANALYSES
1801 N. Beauregard Street, Alexandria, Virginia 22311

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)
In April 1984 the Institute for Defense Analyses was directed by OSD to assemble a task force of senior industry and government people to address the problems faced by DoD in attaining an integrated computer-aided logistics support system. The task force was given a charter to "develop a strategy and a recommended master plan for computer-aided
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Item #19 (continued)

logistic support." The task force was formed and held an intensive series of meetings during the last half of 1984 during which this report was prepared.

Volume I of the report gives a summary of the task force deliberations and lays out a recommended strategy and master plan that would, in five years, have in place all the elements needed for a complete computer-aided logistics support (CALS) system based on electronic data transfer. Volumes II, III, IV and V of the report were prepared by the subgroups that were formed to examine different aspects of implementing a CALS system. These volumes contain detailed information that supports the recommendations made in the Summary, Volume I

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INSTITUTE FOR DEFENSE ANALYSES

Contract MDA 903 84 C 0031
Task T-3-192

PREFACE

This report was prepared by the Institute for Defense Analyses (IDA) for the Office of the Secretary of Defense, Manpower, Reserve Affairs and Logistics Under Contract Number MDA 903 84 C 0031, Task Order T-3-192, "R&D Support to Improve Force Readiness."

The issuance of the report answers the specific task to "...assemble a group of both industry and government personnel...experienced in...computer-aided technologies for automation of support procedures in order to examine issues...include(ing) the subcontractor level, inventory management techniques, etc. At present these issues are being addressed individually without apparent consideration of their interaction in meeting the total DoD objective...to evolve a general plan for automated support of DoD operating systems which addresses the problems of interaction between the different systems now in use or evolving, and the various approaches being taken by DoD to address its readiness problems."

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CONTENTS

REPORT OF THE TECHNICAL ISSUES SUBGROUP

A. SUMMARY

The Technical Issues Subgroup has considered many logistics issues and selected four of particular concern. These are: immediate needs for (1) a general logistics information model; (2) a set of design influence algorithms for logistics; (3) a logistics workstation; and (4) a kernel logistics system. Each of these items is recommended for project demonstration -- probably through application of selected expert/knowledge-based concepts to replace the data-based techniques now in general use.

The Subgroup considered and commented on several additional logistics issues including those related to completely integrated system operations, proprietary rights, embedded electronics, surge situations, standards and many others. Each of these issues undoubtedly is important, but the Subgroup feels that most of them should be "revisited" (reassessed) in terms of scope, objective, impact of new technology and sensitivity to non-technical (policy or management) influences.

The Subgroup members provided and discussed 22 reports that were prepared as Record Documents for the CALS project. These Documents are presented in Appendix A to this report. Several informal study papers and particularly relevant document excerpts from other sources are cited in the List of Study Papers (Section F), but are not included in the appendix.

B. APPROACH

The CALS Technical Issues Subgroup finds that its overall fields of interest require critical identification because many issues which involve their Subgroup appear to involve the counterpart interests both of other CALS Subgroups and other non-CALS groups. Further, the interest of the Subgroup is as much concerned with the interactions among these fields as with the fields themselves.

C. IDENTIFICATION OF THE SUBGROUP'S FIELDS OF INTEREST

A general identification of the Subgroup's fields of interest is shown in the attached road map entitled "Evolutionary Development of CALS," Figure 1, which shows:

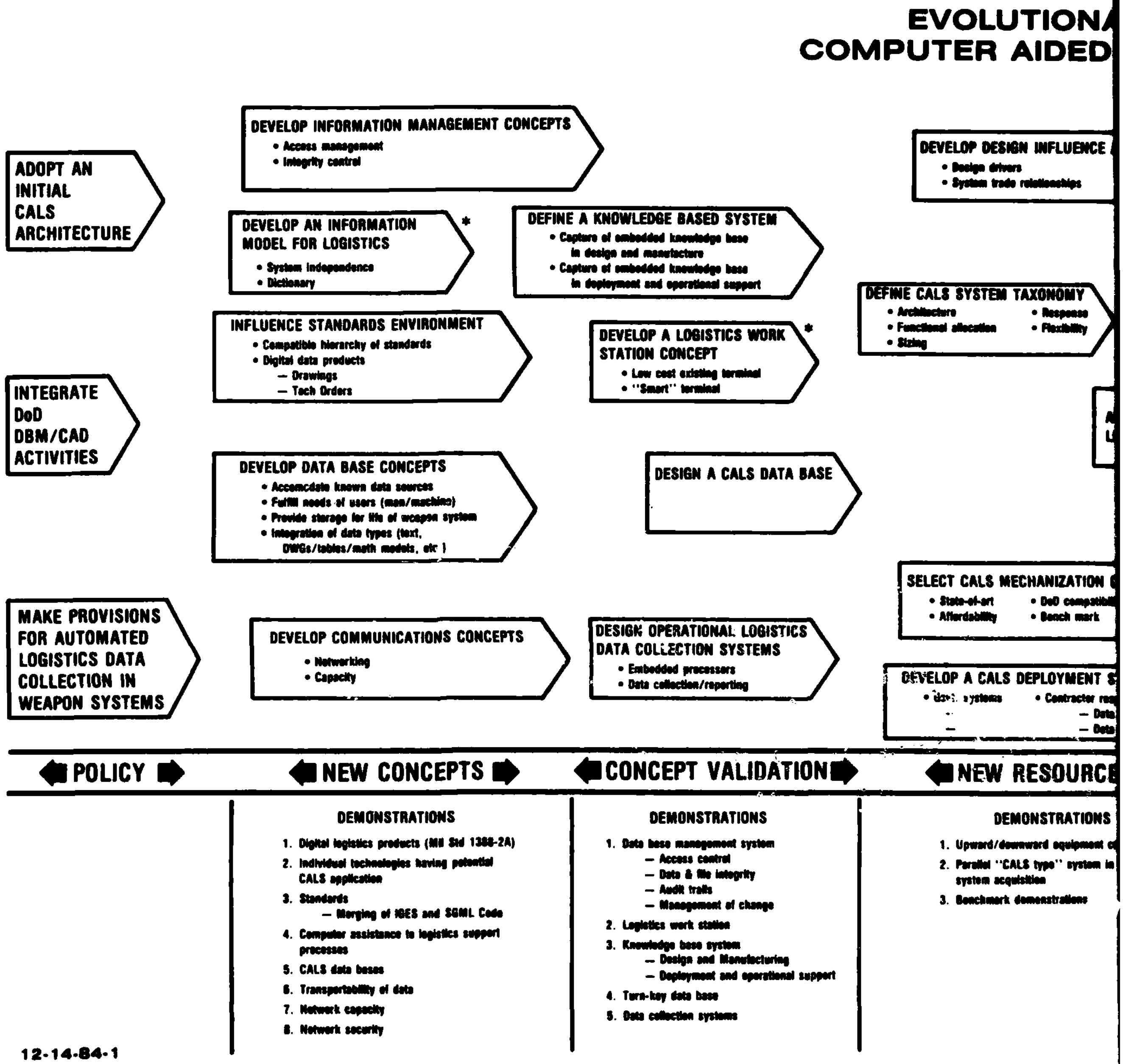
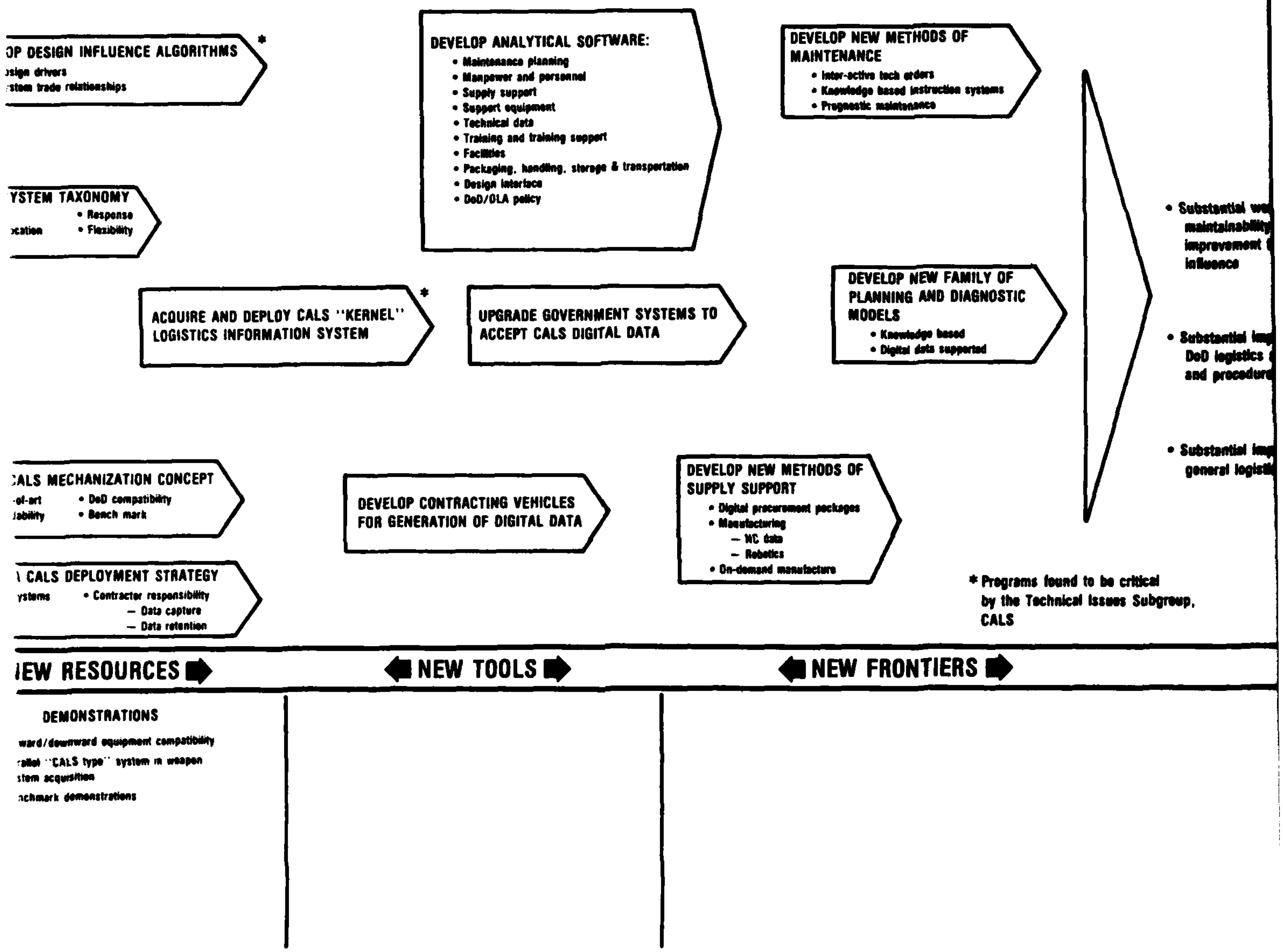


Figure 1. EVOLUTIONARY DEVELOPMENT OF COMPUTER-AIDED LOGISTICS SUPPORT (CALS)

OLUTIONARY DEVELOPMENT OF
ER AIDED LOGISTICS SUPPORT (CALS)



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DEVELOP NEW METHODS OF MAINTENANCE
- Inter-active tech orders
- Knowledge based instruction systems
- Prognostic maintenance

MENT SYSTEMS TO
TAL DATA

DEVELOP NEW FAMILY OF PLANNING AND DIAGNOSTIC MODELS
- Knowledge based
- Digital data supported

DEVELOP NEW METHODS OF SUPPLY SUPPORT
- Digital procurement packages
- Manufacturing
  - NC data
  - Robotics
- On-demand manufacture

- Substantial weapon system maintainability and reliability improvement through design influence
- Substantial improvements in DoD logistics support processes and procedures
- Substantial improvement in general logistics environment

* Programs found to be critical by the Technical Issues Subgroup, CALS

NEW FRONTIERS

1. Major fields contribute to CALS in the same way as these fields contribute to any other computer-aided technology. These include data bases, information management, contracting procedures and standards. The road map also identifies those CALS-related fields that involve issues which are critical to the Subgroup (marked *).
2. A general evolutionary nature of all CALS fields and broad interrelationships among them.
3. The involvement of CALS in the different phases of weapon system development from setting up "Design Influence Algorithms" to evolving "New Methods of Maintenance and Supply Support."
4. The transition from the "what" (data-based) to the "how" (knowledge-based) logistic systems.
5. The need for a logistics information flow model that will show the data sources and the procedures for achieving logistic objectives throughout the entire product life cycle.

Figure 1 also lists possible demonstration projects for implementing CALS. These demonstrations, like the individual fields, have a broad range -- extending from investigating "New Logistic Concepts" to "Benchmarking New CALS Resources."

D. THE RECURSIVE NATURE OF CALS

In contrast to the evolutionary presentation in Figure 1, the CALS concept is intended to be recursive, i.e., it will be applicable *from design to manufacturing*, to field support, and back to design so that logistic steps can be inserted at any point in the life cycle of a targeted weapon system. Thus, CALS has the capacity for (a) achieving immediate logistic benefits during retrofitting, re-manufacturing and modernization; as well as (b) influencing a major new weapon system during its early design phase so that benefits will extend over the total developmental and operational life cycle of the program.

E. SUBGROUP FINDINGS AND RECOMMENDATIONS

1. Findings

The following items summarize the findings of the Subgroup.

1. Standards efforts are needed on
   a. Identifying the overall architectural structure for CALS -- especially to allow integrated work to proceed at distributed locations.
   b. Identifying a set of standards for CALS architecture.
   c. Adopting (early) a set of interface standards.
   d. Reviewing the present FINDER efforts on terms and headings, which requires more attention and possible redirection.

2. Graphic representation effort requires attention on at least three levels.

   a. Digitizing present 2D drawings.

   b. Converting present 2D drawings to digital 3D representation.

   c. Full digital structuring of 3D models.

3. Action is required relative to projected use of the DDN, especially to develop:

   a. A time-phased plan that will show the extent and the impact of CALS requirements on the DDN and the means of accommodating these requirements.

   b. A policy that allows contractors early access to the DDN.

   c. A recognition of the likely need for contractors -- and possibly DoD -- to use alternate commercial facilities, and the means of accommodating this need.

4. Action is needed to emphasize the consideration of supportability requirements in the early stages of design. The Subgroup recommends use of the term supportability in accordance with DoD Directives 5000.1 and 5000.39, rather than the terms R&M, RM&L and RM&S.

5. An acceptable definition or specification is needed for a basic (kernel) logistics system which should be a line item in the Recommended CALS Schedule (line number 3 or 4 is suggested). This basic system should include:

   a. A functional model of logistics information flows.

   b. Algorithms for manipulation of the logistics information in Item a.

   c. A logistics workstation for handling Items a and b.

2. General Recommendations

The Subgroup strongly recommends the following four programs,[1] which include demonstration and validation, in the belief that substantial progress in any of these areas would be a major contributor toward achieving key CALS objectives.

a. Creating a General Logistic Information Model

This model should indicate the times and points of logistic interaction with design and manufacturing in carrying out a generic plan for weapon system development and support -- from the preconcept (or even the requirement/proposal stage) to product disposition. Consideration should extend to logistic products, available logistic data, formats, modes of communication and interaction and a definition of the logistic features

[1] See the Technical Issues Subgroup Reports, Volume V of the supporting report series, for details on these programs.

that are desired in the product design. The Logistic Information Model should be evolved by continual interaction with the logistics community and should include the dynamic characteristics of the logistic process.

b. Developing Design Influence Algorithms

These algorithms should provide definitions and a scale for measuring and prioritizing the various supportability elements (maintainability, reliability, testability, human factors and other logistic objectives), both among themselves and relative to non-logistic features of the product. Particularly, these algorithms must be available and be applied during the early stages of (1) an initial design, (2) an engineering change, (3) product modernization, or (4) item re-manufacture. Any intent to review a proposed design for its logistic impact after its first design review will be too late to be effective.

c. Developing a Logistic Workstation

The logistic workstations will be expected to support logistic interests in such areas as maintainability, reliability, testability and human factors (i.e., the elements of supportability) in the same way that a computer-aided design (CAD) computer supports the designer in the areas of aerodynamics, hydrodynamics, structures, hydraulics, electronics and kinematics (i.e., the elements of performance). The logistic workstation is expected to be capable of manipulating textual, graphic and numberical data to achieve early influence on design decisions. Such a workstation will have both generic software and its own specialized logistic software which will, among other things, apply algorithms for tradeoff analyses and employ complex logistic rules checking to ensure a supportable design.

d. Developing a Kernel Logistic System

The kernel logistic system combines the logistics information model, the design influence algorithms and the logistics workstation into a basic integrated system. It will use the logistic workstation and its algorithms with the necessary logistic data bases (preferred parts; lessons learned during previous design, manufacturing and support; cost driving modes and levels; and dictionaries) along with program management considerations and priorities to achieve an integrated basic operational logistic system. It must incorporate CALS standards and be compatible with general CALS requirements and other interacting processes. This basic or kernel system must be interactive on a real time or a near real time basis. It also must be compatible with CALS and related CAD/CAM systems at both the

terminal and the system level to ensure an adequate design influence. This logistic kernel concept can be expanded either by replication or by expansion to meet the needs for broader interfacing with its design and manufacturing system counterparts. This program, which will incorporate the basic elements of Items "a," "b," and "c" above, should be entered in the Recommended CALS Schedule.

3. Technical Issues

This section provides several technical issues (items) along with the Subgroup's comments. These items require a critical review to ensure an adequate assessment.

Item 1. Total Versus Limited Data Needs

Digitizing the total data requirements of DoD and possibly those of its prime contractors, as seen by its suppliers, would be complex, costly and of marginal utility -- as well as probably beyond the present state of the art.

> **Comment:** Total digital data systems for defense logistics are well off into the future when they will have greater utility. Adequate attention should be given to a near term logistic system and its data requirements -- not as an alternate but as an essential element in the evolution of the total system. Past experience with large systems shows a tendency to overcollect data, overdesign products, underestimate support requirements, underdevelop CAM and overcontrol the various functions. This experience calls for better and more detailed analysis of what is needed to design and support a product.

Item 2. Loss of Proprietary Data Rights

Contractors fear that an integrated CAD/CAE/CAM/CALS data system will result in loss of their proprietary data rights.

> **Comment:** The ten commonly identified separate ILS elements and the presently separate CAD/CAE/CAM/CALS automation efforts provide a hierarchical basis for relieving corporate fears over loss of data rights while setting in motion the development of a strong CALS. Technical concepts are available that will allow the development of appropriate CALS access control procedures. The very critical associated CALS data management architecture needs to be developed, prototyped, and tested.

> **Note:** Items 1 and 2 discuss the technical dimensions of the issues of implementing allowable data access and avoiding actual loss of data. The proprietary rights policy issue of access to data is addressed separately by the Policy and Legal Constraints Subgroup and reported in Volume II of this report.

Item 3. Generic Standards for CALS

Standards are essential to a successful CALS. In particular, standards for data interchange between heterogeneous computer systems -- for example, standards for data formats, communication, and data bases -- are required.

Many of the required standards are in the early development phase, while some are more complete. Complete standards should be adopted where applicable, standards which are near completion should be pushed, and preferred practices or interim specifications prepared where standards are lacking. These efforts should be directed through existing standards bodies to increase CALS leverage. The recommended evolution of CALS standards, as well as the choice of wide-interest (if not yet universal) standards, should serve to forecast the future to all prospective CALS participants. As the demand for CALS-compliant capability increases, the competitive market will respond with products at reasonable cost.

> <u>Comment</u>: Standards are an end product. Earlier, they are proposals for "unification" of protocols, formats and procedures. Many benefits of standards can be achieved by preparing and calling out (1) preferred practices, (2) pre-standards, or (3) interim standards. These documents are relatively effective. They also can be developed rapidly and they are less costly.

Item 4. Specific Standards for CALS

An integrated CALS system must have internal standards, such as standard names, descriptors, and procedures. These should be common across the Department of Defense.

> <u>Comment</u>: A naming standard is underway to develop a list of approved class words, key words, and modifiers -- in other words, a classification and coding of data for an orderly dictionary to support the IDS System. The pre-standard terms in current use can be a problem, but many powerful techniques such as relational data base management schemes may prove to be at least a partial solution to this problem.
>
> In order for typical military personnel to easily use and understand the output for automated logistics systems, a good information dictionary is needed. An information dictionary identifies symbols, meanings of symbols, the relations between symbols, and constraints in the use of those symbols.
>
> Currently available dictionaries are inadequate in these basic concepts and are incomplete in their functions. Recent work in information modeling theory provides a basis for the design of an appropriate information dictionary, but extensive development effort is needed to produce an appropriate CALS information dictionary.
>
> <u>Note</u>: The customary reticence of commercial enterprise to accept standards can be turned toward enthusiastic participation by careful identification of the status of each

standard (see first paragraph) and equally careful description of the context of use and the advantages to all concerned resulting from their use in CALS work.

Item 5. Design Decision Support

A total information concept is necessary to ensure support of a weapon system for decades after it is designed (showing the design assumptions and hypotheses so that subsequent changes do not re-insert the very features that were eliminated from consideration during the original design.)

Comment: Detailed records of design appear to be very desirable -- especially for the selected design and for the thoroughly analyzed alternative (rejected) design features. However, annotated log entries on the selected design and many of the rejected features may be adequate records of the disposition if the log provides adequate guidelines for reconstructing the basis for the original decision.

Item 6. Embedded Processors and CALS

Developments in computer-aided technologies make possible the use of embedded processors as sources of essential logistic data. These embedded processors differ from the usual CAD/CAM/CALS computers to such a degree that the effective use of their output is a challenge to the CALS.

Comment: The rapid development and expanded use of embedded processors is a valuable aid to anticipating logistic needs and to impressing these needs on the conceptual design of a weapon system. Properly considered, these computers offer a welcome potential for more complete, more accurate and more timely logistics data gathering, reduction and use.

Item 7. CALS During Surge

The CALS must be more flexible than is suggested by its present strong focus on a seemingly idealized early attainment of its ambitious technical and organizational goals.

Comment: Some logistic-related computer-aided technologies were "given some consideration" during recent surge (limited mobilization) studies. CALS issues must be strengthened and set forth more convincingly in order to get more serious consideration during such surge studies. A proven CALS capability can be a valuable decision-aiding tool during future exercises.

Item 8. Digitizing of Drawings

The problems of working with both conventional and a variety of digitized (CAD) drawings in the same product program suggest the need for a large-scale conversion of present drawings to digital format and their accommodation to other automated requirements.

> Comment: Current technology and practice expresses all parts specifications on the medium of an engineering drawing designed solely for human interpretation. Future requirements are for this part definition to be captured electronically for ease of communication, for archival integrity and for interpretation by computer.
>
> Digital scanning of existing drawings allows the drawing to be electronically stored and transmitted over communication channels and reproduced at the other end. Current scanners, data compression techniques, laser storage systems, and laser printers provide most of the necessary technical tools required to effectively utilize digitized drawings.
>
> Present part models are expressed as 2D wireframe, 3D wireframe and 3D surface geometric models. Each of these representations is incomplete in terms of the total information content needed for analysis or for automated manufacturing planning. Solids models are seen to be the approach to give the required "completeness" to the product model.
>
> CALS must recognize this diversity, accommodate the technological trends and plan for the effective utilization of these various forms of data models. New technology developments should be supported and related standards activity encouraged. Validation techniques should be created to check the integrity of data received by DoD in any of these forms.
>
> Recognizing there will be a variety in the forms for digital representation of product model data, the CALS program should encourage the creation of translators to change the part model from one particular digital form to another form.
>
> In the order of sophistication, completeness and complexity, these forms are:
>
> Digitally Scanned Drawing
> 2D Wireframe Model
> 3D Wireframe Model
> Surfaced Model
> Solids Model.

Translators to convert a more sophisticated model to a lesser sophisticated model will be relatively easy to develop. The reverse will be far more difficult. However, it will be these translators that will be far more valuable to DoD over the life span of the archive data files, for they will enable an easy transition to new technology tools for logistics support. Example translators might include either 2D or 3D Wireframe Model Creation from scanning of an engineering drawing.

4. Future Developments

All of the Subgroup's fields of interest -- including their related issues -- are candidates for future implementation as artificial intelligence-based or expert/knowledge-based systems. The lack of needed knowledge or technology should not delay logistics developments leading toward knowledge-based systems so long as the possible later transition from data-based to knowledge-based system operation is given appropriate early attention.

F. LIST OF THE SIX STUDY PAPERS CONSIDERED BY THE SUBGROUP[2]

1. "Supportability (S) Program - Appendices," Erich Hausner, Lockheed, November 1983 (58 pages).

   The contract report presents a model for relating supportability (S) and life cycle cost, giving an interface matrix and the needed computations.

2. "Definitions of Terms for Supportability," (Military Standard 721C-XXX, Proposed) Erich Hausner, Lockheed, November 1983 (137 pages).

   This report includes 107 pages of supportability definitions plus abbreviations and Design-to-Requirements (SDTR) codes.

3. "Future Functional Allocation Between Government/Contractor," Kurt Molholm and Bill Presker, Defense Logistics Agency, October 1984 (4 pages).

   This report considers several aspects of turn-key vs more detailed allocation of responsibility in several areas of logistic concern, especially in the spare parts field.

4. "Role of Experience Data in Logistics Planning," G. L. Foreman, Hughes, October 1984 (24 pages).

   The report identifies sources of existing logistic data, its assessment and its use. Also included are comments on evaluation of a user's R2M procedures.

5. "Unified Data Base for Logistics Information - A DoD Statement of Work," (via) Fred Macey, Lockheed, September 1984 (17 pages).

   This contract work statement covers four phases of UDB activity: technology development; test and demonstration; evaluation; and transition.

6. Five Sets of Charts Showing CALS-Related Data/Information Flows (nine pages, see next page).

[2] For more information concerning these papers, contact the Institute for Defense Analyses.

The exhibits listed below show various approaches and interpretations of logistic information functions at different points in the product life cycle.

CALS-RELATED DATA/INFORMATION FLOW DURING THE LIFE CYCLE OF A DEFENSE SYSTEM

Title	Sheets	Author/Source	Date
CALS Supportability - a New Dimension in Design	3 - 24"x30"	E. Sausner (Lockheed)	-
CALS-Related Functions During the Life Cycle of a Weapon System	1 - 12"x72"	-	-
Generic Life Cycle Representation for Defense System Acquisition	3 - 12"x30"	Saunders	1984
Engineering and Test Flow	1 - 4"x12"	-	-
Acquisition Life Cycle Technical Activities	1 - 24"x36"	Booz, Allen & Hamilton	1984

LIST OF REPORTS PREPARED BY THE TECHNICAL ISSUES SUBGROUP

CONTENTS AND SUMMARY

The report discusses the Integrated Design Support System (IDS) study as it is applied to the B-1B bomber. It further considers other information systems and neutral data bases, and touches on the Air Force's Logistics Technical Support Center (TSC). Nine graphics exhibit pages summarize the report concepts.

The report presents a preliminary concept for showing flow of information from a normal repository through a typical computerized process and back to a repository. It considers the total life cycle of a product; however, the figures themselves are incomplete.

The report poses several questions about the scope of CALS and offers a strategy for its implementation. It presents time-based diagrams showing the percentages of automation in (1) drawing preparation and (2) parts list preparation from 1960 to today, and projects estimates to the year 2000. The report further presents a chart showing the role of technical management in automated design, procurement, manufacturing, testing and logistics.

The report emphasizes payoff of CALS as it relates to both industry and government in the near term and the long term. It considers the incentives and the barriers to expanding CAD to include supportability.

5. "Issue - Support of Contractor/DoD Decision Processes."
G. L. Foreman, Hughes, October 1984 58

The report addresses the decisionmaking process in terms of (1) data changes, (2) data additions, and (3) the remaining unchanged data. It stresses the problems of maintaining an audit trail that considers both the results of a decision as well as the rationale for making the decision.

6. "Limits on DoD Action."
George W. Fredricks, IBM, October 1984 63

The report discusses new (as opposed to adapting present) capabilities of CALS. It addresses Standards, Implementation Networking, Security, Flexibility, and Proprietary Information.

7. "Points for Highlighting in the CALS Program."
Ernest Glauberson, U.S. Navy, NAVSEA, October 1984 73

The report considers such problems as overcollecting data, overdesigning products, and underestimating support. It discusses the use of expert systems and process models in the solution of such problems. It further distinguishes between the need for unification of protocols, formats, etc., and the later establishing of standards.

8. "CALS Demonstrations: Process and Recommended Areas."
Ray Bourn, IBM, September 1984 84

The report recommends having at least two contractors address the same technical issue at the same time in demonstrations using subcomponents of a weapon system as a test vehicle. It suggests areas for emphasis and sets forth a three-phase plan for implementation. It also suggests areas for future CALS research.

9. "The Computer-Aided Logistics Support (CALS) Project."
William Tunnicliffe, Graphic Communications Association 88

The report presents, in text and figures, the scope of proposed Handbook 84-101 and the total set of graphic standards involved. It also presents a conceptual outline of publications and the relationships of the graphics processes and standards.

10. "Technology and Standards Issues Related to Computer-Aided Logistics."
Robert J. Hocken, National Bureau of Standards, September 1984 98

The report discusses the set of standards that is needed for CALS, including those for communications, graphics, text, product definition, and data bases. It also presents a set of recommendations that addresses both needs and plans for implementation in this area.

11. "IGES: A Key Interface."
Bradford Smith, National Bureau of Standards, October 1984......................107

The report describes the procedures that have been used to develop the IGES standard to date and lists the vendors that have participated in public inter-system exchange of data on an illustrated test part.

12. "Foreman's Concept 'A' - Logistics Tool: Creation vs Use."
G. L. Foreman, Hughes, February 1983...122

The report presents, in text and chart form, the three levels of logisticians and their respective involvements during the different phases of the product's life cycle.

13. "Access Control, Management and Integrity of Information."
Robert R. Brown, Hughes, October 1984..125

The report discusses the importance of the listed topics and present limitations in our ability to handle these items. It lists three factors that are important in assuring integrity of CALS information.

14. "ANSI Data Element Dictionary."
Robert R. Brown, Hughes, November 1984..129

The report reviews the two recent ANSI standards in this field that should be applicable to CALS and finds that they are inadequate. The report states that many of the computer tools needed to solve the data dictionary problems are available but that much work needs to be done to achieve a solution.

15. "Network Example - Seven Layers of the International Standards Organization (ISO) Data System Model."
Bradford Smith, National Bureau of Standards, 1984...............................131

A series of tables shows the seven layers of the ISO model along with the function of each layer. It also shows the General Motors' MAP emerging factory standard and the approval status of ten major graphics and data base standards.

16. "Gencode*/SGML Strengths in the Text Processing Environment."
William Tunnicliffe, Graphic Communications Association,
December 1984..145

This is a three-part report that summarizes CALS recommendations in the GENCODE*/SGML standard areas and presents the development status for these s.andards. The figures show the relationships between the various standards and the process steps that relate to these standards.

17. "Standards Development Organizations Structure and Participating Personnel."...171

This two-part report (17A, 17B) is a complete review of ANSI and ISO groups and individuals working on standards development in fields of interest to CALS.

The report discusses standards activities in tooling, fabrication and communications for manufacturing. It considers the primary interface standards needed for interchangeability of manufacturing data. The report also gives the status of pending standards actions in this field and lists the organizations/individuals participating in the effort.

This is an outline of the standards efforts that are underway in the information processing field. (NOTE: Information about a 60-page compilation of standards organizations and their structure, along with the active individuals and their affiliations, can be obtained from IDA.)

This visual presentation material develops the concept of supportability as a very broad logistics objective. Inasmuch as Reliability (R), Maintainability (M) and Support have been identified as major considerations in the front-end of product design analysis, this report emphasizes that the major issue is design for Supportability (S). Recent research has pointed out that supportability can be related directly to sortie generation in the case of combat aircraft.

The report describes the need for identifying and characterizing the logistics information sets and their flows during the full life cycle of a variety of defense products. It recommends an implementation plan for setting up such a model, listing individual tasks, a calendar schedule and an estimated funding level for achieving its objective.

The report describes the need for logistics algorithms that can be used effectively by the product designer early in the design process. A list of recommended tasks is provided but the project is viewed as continuously developing, thus no time schedule or level of funding is given.

21. "The Logistics Workstation."
The Technical Issues Subgroup, November 1984..................................224

The report points out the need for a workstation that is functionally comparable, in the logistics field, to the present CAD workstations in the design engineering field. It lists the main characteristics, benefits and points for early application of such a facility and it provides recommended tasking and time scheduling for the project.

22. "The Kernel Logistics Information System."
The Technical Issues Subgroup, November 1984..................................228

The report addresses the concept of deploying computer automation into a highly distributed data system, giving the logistics facility a basic system structure. It lists the major tasks for implementing this concept and it recommends a time scale and tasks for immediate funding.

23. "Initiatives in Automated Technical Information."
IBM, June 1984..232

A series of charts presents a synopsis of a meeting on ongoing and planned activities to automate the flow of technical information at the IBM Federal Systems Division facility in Manassas, Virginia.

Appendix A

LIST OF REPORTS PREPARED BY THE TECHNICAL ISSUES SUBGROUP

REPORT NO. 1

SHARED DATA - KEY TO ACHIEVING IMPROVED PRODUCTIVITY THROUGH COMPUTER AIDED LOGISTIC SUPPORT

A. INTRODUCTION

The objective of this paper is to explore the aspects of logistic support data requirements for an emerging weapons system and to suggest a logical approach for transition from current information support systems of today to shared data structured systems of tomorrow.

The B-1B bomber was selected as a typical example of an emerging weapons system for this discussion because of its position in the development and deployment phase. Logistic data bases that are currently being developed will support this weapon system well into the next century. The current functional and informational data models for these logistic data bases are derived from a conceptual design study. This study, identified as the Integrated Design Support System (IDS), is required for the development of an advanced engineering support information system. The conceptual study was funded by the U.S. Air Force Wright Aeronautical Laboratory. The models developed under this study were focused on sustaining engineering support to B-1B design, manufacturing, depot and field support activities and are generic to many emerging weapons systems.

B. THE PRESENT (AS IS) LOGISTIC SUPPORT DATA ENVIRONMENT

Considerable industry and government attention has been focused on both the development and integration of automated business systems and on the development of computer-

aided engineering systems. Little effort, however, has been applied to the integration of computer-aided engineering systems or to the design of systems to acquire, manage, and communicate graphical, alphanumeric, and textual data in various combinations. Research and development work has been performed on generic data base management technology under the IPAD*, ICAM, and ATI programs, but this technology has not been exploited on a broad level for the development and deployment of major weapon systems.

A wide range of technical support activities provide product technical data services from conceptual design through manufacturing, weapon system operations, and product retirement. A top level schematic of organizational technical support activities for the B-1B aircraft system development program is shown in Figure 1. The diagram is intended to depict sustaining engineering support activities that use engineering data directly such as manufacturing material review, repair, depot repair and design modifications. It should be noted that significant secondary uses of technical support data are not shown in the diagram such as trainir . maintenance provisioning, and operations mission analysis

Current emphasis by both the government and industry is in the development of organizational rather than data driven systems. In the development of a weapon system, the traditional technical support data bases that are passed on to the contracting agency are engineering drawings, specifications, and technical orders for maintenance support. The remaining technical data bases that reside with the

*IPAD - Integrated Programs for Aerospace Vehicle Design - NASA
ICAM - Integrated Computer Aided Manufacturing - USAF
ATI - Automated Technical Information - USAF

contractor are significant. An example of structural technical support data bases for the B-1B is shown in Figure 2. It should be noted that a majority of digital and graphic data bases are considered private. These data bases are controlled by design and analysis support organizations and are not maintained as official released data.

There are a number of inplace and emerging logistic informational systems both at contractor and government facilities. An example of key Rockwell and government logistic systems that utilize or manipulate information is shown in Figure 3. Today's technical support systems are generally hierarchical in nature, are transaction driven, and many operate in a batch environment. Data resides in a heterogeneous computer environment and are generally non-communicative between dissimilar computer systems. Specific problems and issues with today's heterogeneous logistic support information system environment are discussed in the following paragraphs.

While technical computer innovations and data system automation are progressing at an accelerated rate, integration through shared data is progressing slowly.

Information systems have not been developed from a data driven approach, but rather from an organizational or application driven approach. Present information systems serve discrete user needs. Redundant product support data must be maintained or recreated in many data bases.

Neutral data formats are being developed that address geometric and textual data communications between computers and graphic terminals. Two such systems are IGES and GENCODE. Development of these systems is currently evolving. Technology that is currently lagging involves heterogeneous data control

and manipulation. This problem is partly due to the computer vendors and the competitive nature of industry and government functional organizations.

In the development of a weapons system, data is acquired in the form of discrete CDRL's (Contract Data Requirement List). Even though there is a determined relationship between many if not all of the data deliverables, such as drawings, specifications, and technical orders, the data is delivered to government organizations and stored as separate data systems. These information systems include paper, micro-fiche and magnetic storage mediums. Even though transition to digitized data bases is occurring, the prevailing mentality of information management remains in the paper medium.

Present government automated logistic technical data base development programs (EDCARS*-computer based drawings, and ATOS-automated tech orders) do not address the aspects of shared data outside of their own application. Furthermore, government logistic support organizations have not developed overall strategies for dealing with new digitized design and analysis data bases that are required for long term logistic support of major weapon systems. Examples of such data bases are referenced in Figure 2.

Current trends encouraged by the Air Force Logistics Command to consider the logistic implications of a weapon system at design time can be expected to continue. However,

*EDCARS - Engineering Data Collection and Retrieval System - USAF

ATOS - Automated Technical Order System - USAF

*EDCARS Engineering Data Computer Assisted Retrieval System USAF.

the attitude of both the customer and the system designer must change for this to be the case. The customer (the Air Force in this instance) must not only encourage the contractor to design supportability into the system, but must also be ready to fund the additional effort this requires. Once chartered by the conditions of the contract, the system designer must be as creative and as innovative as possible in anticipating the future requirements of the weapon system, not only from the operational point of view, but from the damage repair and maintenance point of view as well, a not inconsequential challenge considering the complexity and sophistication of today's weapons.

The computer offers the maximum opportunity to support the system designer in accomplishing ambitious design goals. Hardware manufacturers can be expected to deliver increasingly sophisticated tools for storage, computation and manipulation of data. Trends in firming up programmed engineering design rules and processes by means of reducing them to PROMs and EPROMs and offering this capability at the touch of a key will also continue. Software houses will continue to provide the engineer with an increasingly capable array of data base management systems designed for more flexibility at less cost with more reliability.

"Where is the challenge, then?" one may ask. In a word, the challenge is in the data. The management of this critical asset poses a challenge equal to the technology which conceived it. The subtlety of the challenge is that few people intuitively appreciate the magnitude and complexity of the data problem.

The system designer may perceive the major problem to be addressed as a computational problem and only incidentally

a data problem. After all, shouldn't the data be regarded as a given? From the individual designer point of view the data might be regarded as something solely personal and individual but a moment's reflection dispels this notion. The conventional view has it that when the design data is firmed up it can be released and configuration management imposed on it. This has worked reasonably well for the manufacturing and downstream functions of the contractors and subcontractors, before delivery of the system to DoD, who must now service, maintain and repair the system in an operational environment. Many years or even decades later, after numerous repairs and modifications have been implemented on the system, the original design data may have been lost, the original manufacturer may no longer be in the same business, and design assumptions and hypotheses may have to be guessed at.

Will this situation suffice for the weapons systems of today as these systems age in operational service? The computer offers the mechanism with its ability to store and manipulate vast amounts of data with acceptable speed. Data, defined at the attribute class level, documented as supporting a particular function in the data model, and available from a shared source on a node of a heterogeneous network utilizing secure communications seems to offer a necessary and required asset, one which is lacking in today's logistics environment.

C. FUTURE (TO BE) LOGISTIC SUPPORT INFORMATION SYSTEMS

The "To Be" world addressed by the IDS system envisions a scenario similar to the one described above, and work is starting on the disciplining of the data. The current world seems to be "forms" driven, there is a form for

everything, and everything has its form. Forms are a necessity in a paper environment. How else to assure the completeness of the data or its location in the manual filing systems of yesterday (and, unfortunately, of today)? The electronic world can be forms independent and offer flexibility undreamed of in a paper based media. But much needs to be accomplished in the science (or art) of managing the data before this becomes a reality. A naming standard for the technical data world of tomorrow is just now being formulated. It includes developing a listing of approved class words, key words and modifiers, in other words, classification and coding of data. The use of this device will attempt to bring order in the dictionary as attributes and entities are gathered across the vast range of functional activities served by the (IDS) system.

The key to achieving future DoD productivity in weapon system support is in the development of data driven rather than organizational driven systems. Future logistic information systems need to address the following issues:

- Reconfiguration of contractor and DoD structure and organizational policies
- User and application designed "ad hoc" queries
- Total product support rather than individual CDRL's
- Heterogeneous data base managers on heterogeneous computers
- Hardware-oriented data base machines
- Versatile generative combinations of data elements
- Effective classification and coding schemas

The development of computer aided logistics support should be an orderly, evolutionary process with appropriate

DoD component service policy guidance and successful resolution of key technical issues. The policy will be required to address three key issues:

1. Commitment to a broad program architecture that will permit development in a systematic manner.
2. The integration of developing data base management technologies into rapidly maturing CAD/CAM/CAE technologies.
3. The establishment of requirements for future weapon system designs to support automated logistics data collection activities necessary for emerging support concepts.

Key technical issues must be addressed through the extension of evolving information system concepts -- and, in some instances, new concept developments. Influencing of the standards environment to achieve a compatible hierarchy of standards is necessary for handling the full range of logistics data in digital format.

A key to the success of computer aided logistics support is the ability to develop an information model for logistics. Today, each logistics data requirement is like looking at the weapons system through a knot hole -- not seeing the whole and not having data relatable to other data. Data base concepts will be required to accommodate both man/machine and machine/machine users. Data storage has to be viable for the life of the weapons system (30 years plus). The integration of data types, (i.e. text, graphics, tables, math models, etc.) has to be achieved to preserve information context. Information management concepts for access and integrity control throughout a wide-spread network of users will present a challenge.

Logistics data can be expected to transition from information (the "what") oriented to knowledge (the "how") in recognition of the capability of capture of an embedded knowledge base in the design and manufacture of a weapons system and in the deployment and operation of weapons systems. The embedded knowledge will be more accessable as computer assistance becomes inherent in the processes that build and operate future weapon systems.

The first tangible product in computer aided logistics support is the deployment of a "kernel" logistics information system. Such a system will require a concept for a logistics workstation -- using a low cost existing terminal, and a design of a logistics data base. Once the "kernel" system is deployed, new analytical software will evolve for every element. This software will provide capability beyond currently available tools as it incorporates access to new data base resources.

Government systems will require upgrade to accept digital format logistics data. New contracting vehicles will be required to define, specify and receive digital logistic products.

The above is at best only a glimpse into the new frontiers that can be achieved through computer aided logistic support. A time phase road-map of capability with some key technical demonstrations is shown in Figure 4. This is intended to show general direction and is not a specific plan. What is described in Figure 3 is a major undertaking involving coordination throughout DoD and the defense industry.

D. INTEGRATED DESIGN SUPPORT SYSTEM (IDS) TECHNOLOGY WEDGE

The U.S. Air Force Human Resources Laboratory (HRL) and a coalition of USAF and technology subcontractors headed by Rockwell International are currently developing and prototyping an advanced information technology system called IDS.

The objective of the IDS program is to design, develop, construct and demonstrate a prototype information management system that will provide capability to efficiently capture, manage, and distribute key digital technical data across the entire life span of major Air Force weapons systems. (See Figure 5.)

The major IDS program challenges and goals are summarized below:

(1) To develop a prototype IDS system that will demonstrate integration of state-of-the-art and emerging technology to manage technical data in a heterogeneous computer and functional environment.

(2) To develop engineering functional and information models that provide a complete understanding of data and activity structure from conceptual design to product retirement for a major, emerging military large aircraft system.

(3) To construct, build, and demonstrate a flexible IDS prototype system that can be rapidly expanded as new technologies emerge in the areas of data base machines, advanced design and analysis graphics, advanced communications, and artificial intelligence.

(4) To assure that the system design reflects capability for upward migration and portability.

(5) To develop the IDS concept in a production environment that will provide a realistic test bed for requirements definition, prototyping, initial build, and demonstration.

(6) To structure the IDS design so as to facilitate transition of the system from the research and development and prototype stages into a production system.

(7) To demonstrate and prototype IDS in a manner that will provide the baseline for future technical information management on all Air Force weapon systems.

(8) To formulate draft requirements to be used as a baseline for establishing technical data requirements for future Air Force systems.

Rockwell is also involved with the Analytical Sciences Corporation of Reading, Massachusetts in the initial phase of an Air Force program to develop and implement a B-1B Logistics Technical Support Center (TSC). This program will establish a management and technical center for Air Force logistic support for the B-1B weapon system. The center will also provide operational/readiness status capability to the Air Logistics Center (ALC) B-1B system manager and will provide technical information support between contractor, depot, and operational repair facilities.

The IDS will provide advanced data base management and communications concepts in support of the TSC. Advanced prototypes of the IDS (Advanced Information Management Concepts) and the Technical Support Center (advanced control and technical communication concepts) are scheduled for fiscal 1986.

The attached graphic exhibits presents the evolving IDS concept as it is applied to a major weapon system -- the B-1B Bomber.

E. SUMMARY

The United States Air Force is stepping beyond traditional methods of data base management in the IDS program. More powerful microcomputers and data base machines, new data and information models, and the effective use of distributed data in a heterogeneous environment are all part of this research effort. IDS could well prove to be the data base solution that everyone is looking for. If so, the significance of IDS could be tremendous resulting in replacement of more standard data structures thereby reducing computer and storage costs and providing networking between dissimilar computer systems. Every government agency, as well as all of industry, needs this capability. The IDS program will prove workable concepts in a prototype system before transferring these developments to a production system.

John Willis
Darrell Cox
Rockwell International
October 10, 1984

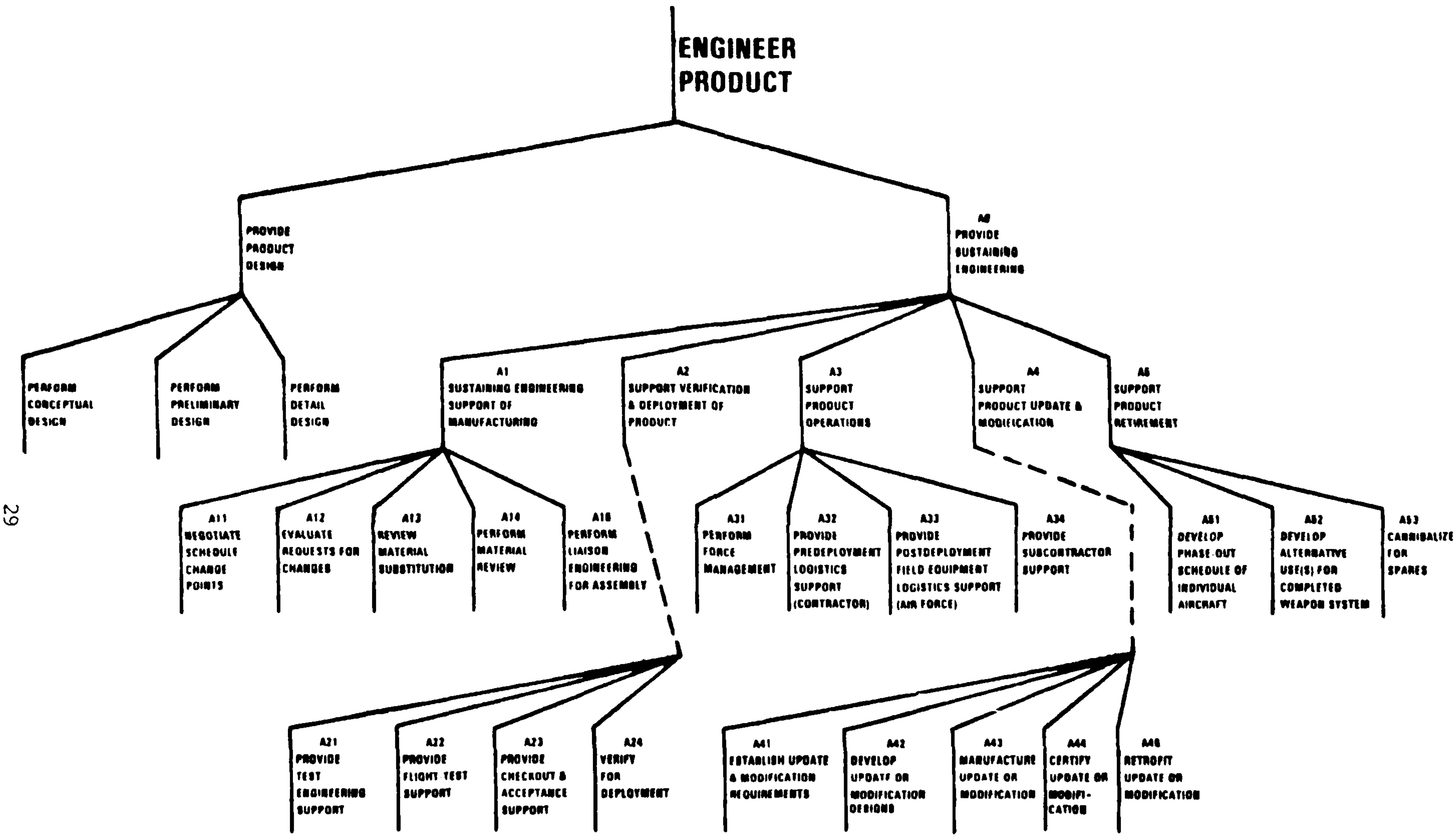


Figure 1 - B-1B Sustaining Engineering Support Funtions
(Top Level View)

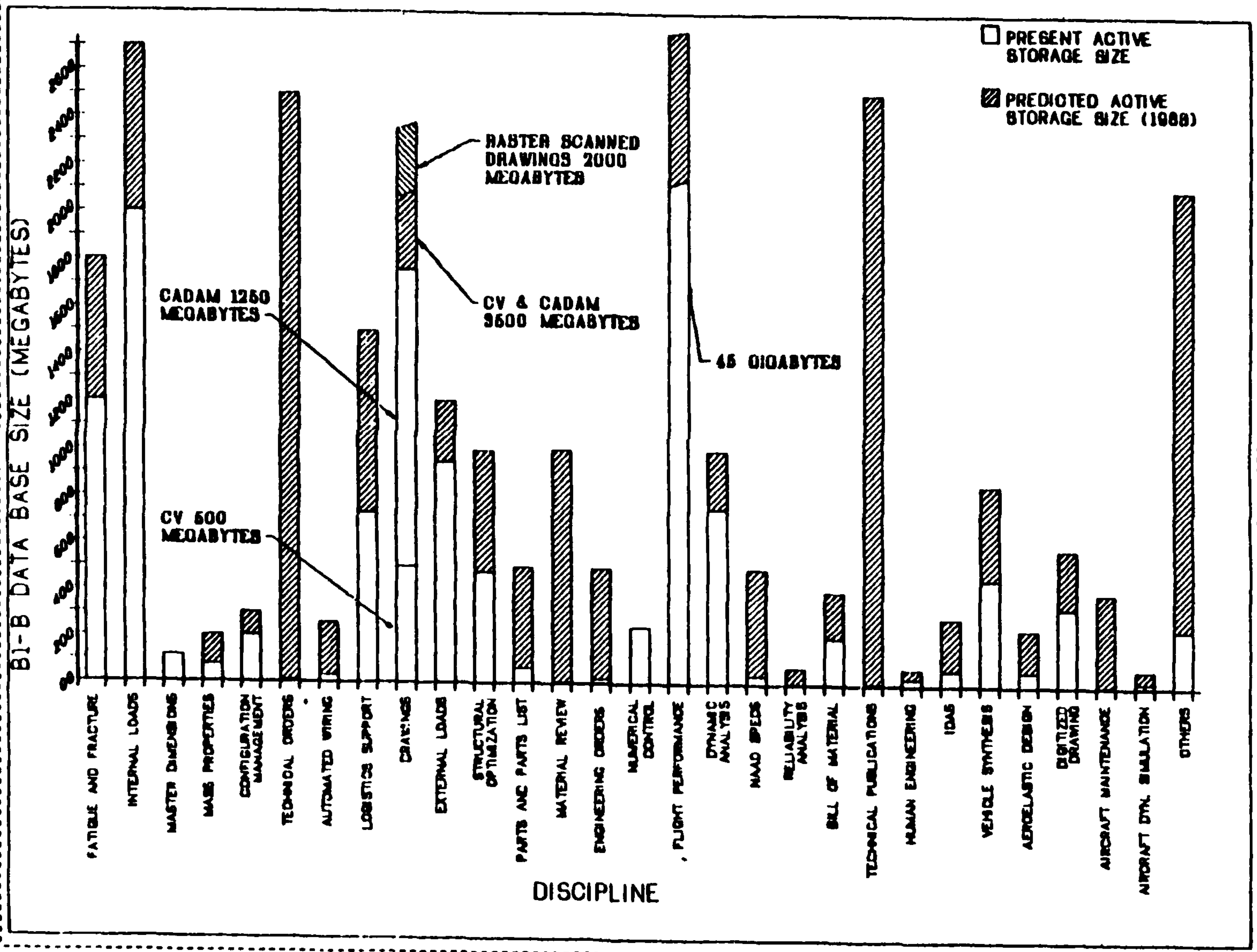


Figure 2 - Examples of Key Engineering Support Data Bases

FIGURE - 3

SELECTED MAINTENANCE LOGISTICS SUPPORT DATA SYSTEMS
CONTRACTOR AND GOVERNMENT

Rockwell Management and Data Systems

LMDS - Logistics Management Data System

LSDS - Logistics Support Data System

PIOMS - Provisioned Item Order Management System

SEMIS - Support Equipment Management Information System

TOTS - Technical Order Tracking System

LIMS - Logistics Inventory Management System

ICSIS - Interim Contract Support Information System

MCC-ICS - Management Control Center Interim Contract Support

MCS Boeing - Management Control System

CETS - Contract Engineering Technical Support System

IDS - Integrated Design Support System

CITS - Central Integrated Test System Ground Processing System

EACN - Emergency Airborne Communications Network

U.S. Air Force Management and Data Systems

CAMS - Core Automated Maintenance System

OMS - Logistics Management System

LOC - Logistics Operations Center

IMMS - Integrated Maintenance Management System comprising MICAP, MDC, AWP, and AVISURS

CMS - Combat Maintenance System

WSMIS - Weapon System Management Information System

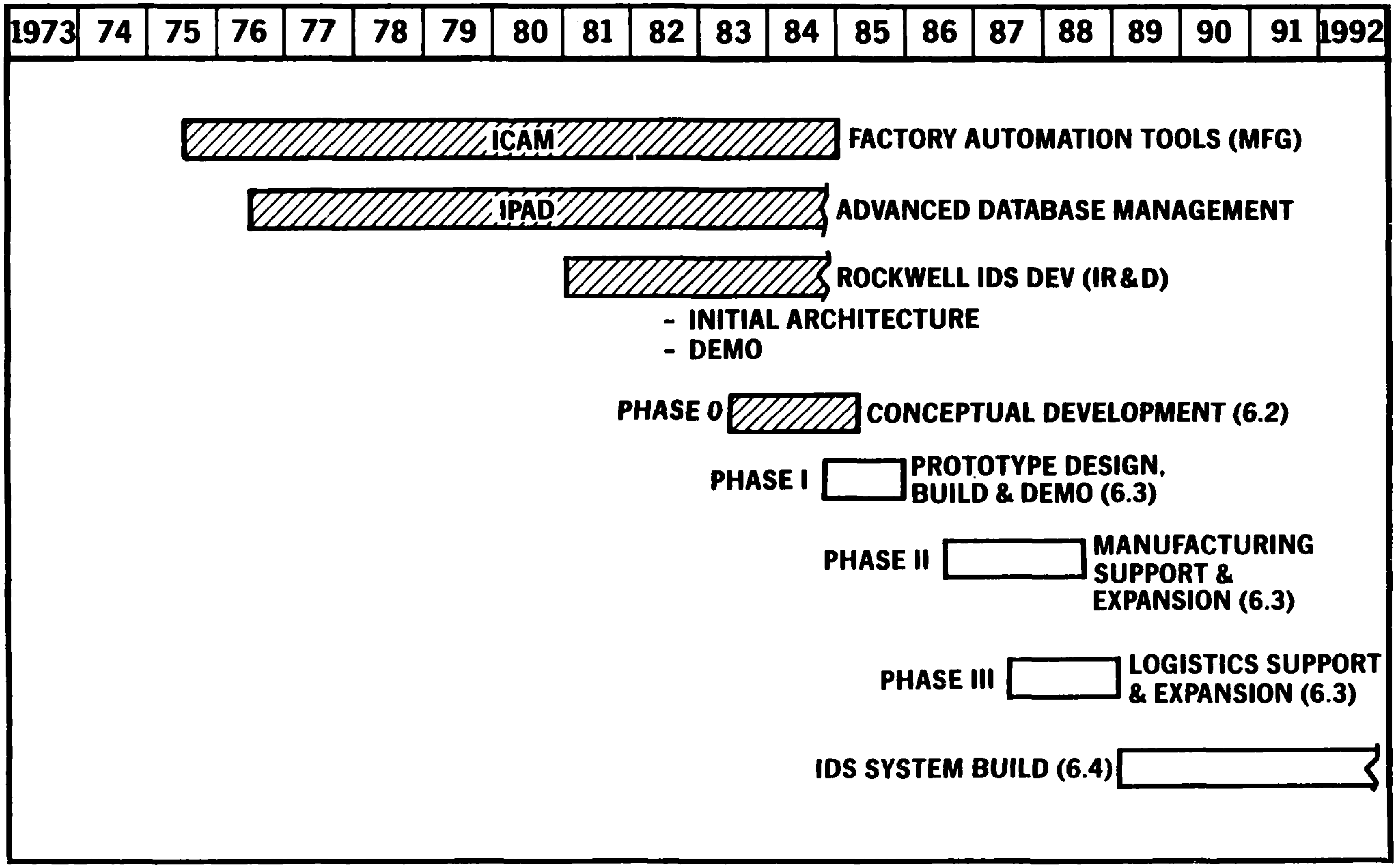
SAC - Strategic Air Command Operational Data

MICAP - Mission Capability System

MDC - Maintenance Data Collection

AWP - Awaiting Parts System

AVISURS - Aerospace Vehicle Inventory, Status and Utility Reporting System



DS1-84-0475

Figure 4. IDS HISTORICAL DEVELOPMENT

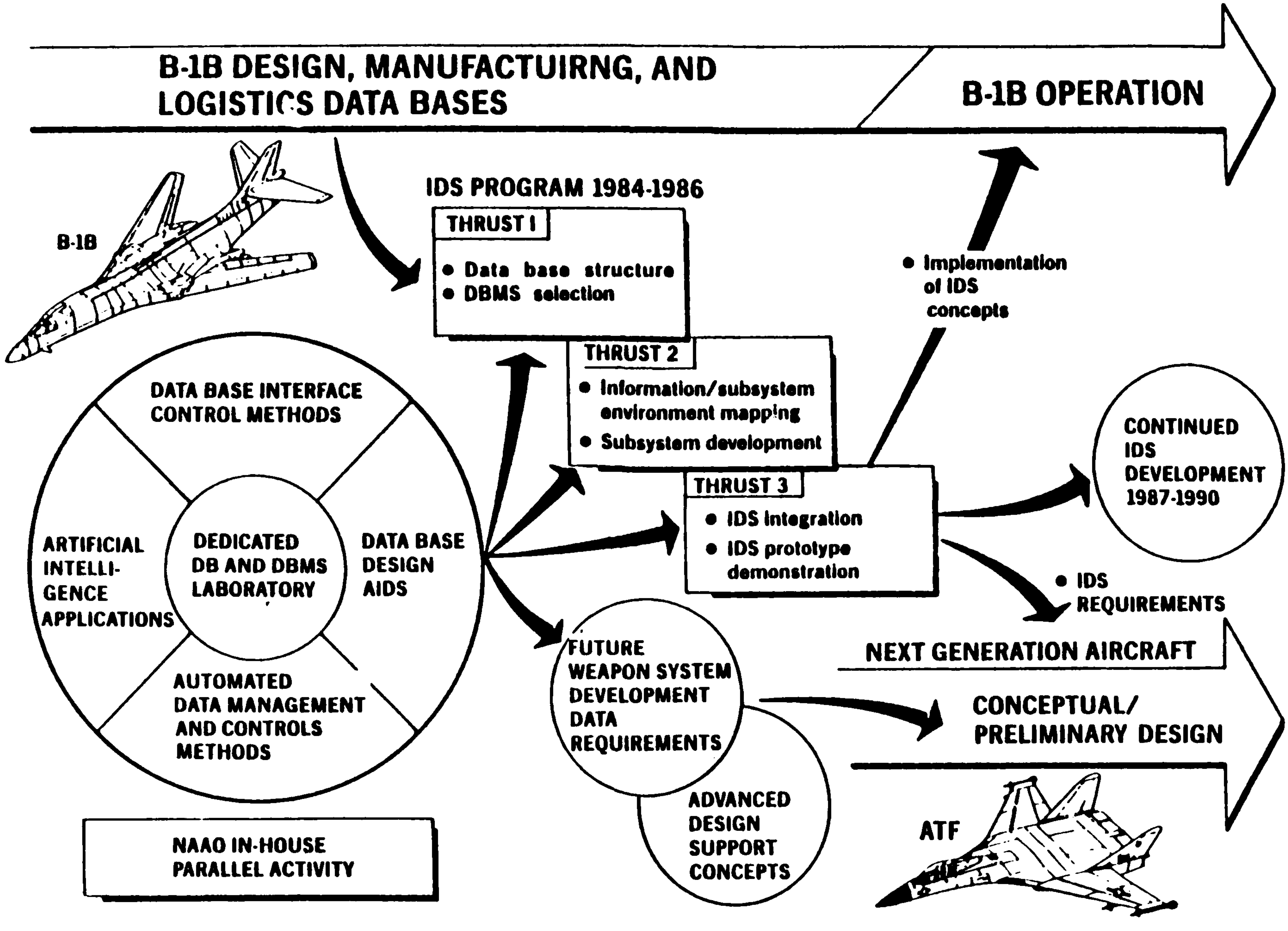


Figure 5 - IDS Cevelopment Program Relationships

REPORT NO. 2

FLOW OF INFORMATION IN DEFENSE PROGRAMS EMPLOYING STATE OF THE ART LOGISTIC TECHNOLOGY AND A GENERAL LOGISTIC INFORMATION MODEL

October 19, 1984

by

Darrell Cox, Rockwell International
George Beiser, Institute for Defense Analyses

FLOW OF INFORMATION IN A GENERAL LOGISTIC INFORMATION MODEL

The CALS has, as its root, a concept that is broad enough to encompass each individual logistic function across the entire range of weapon systems, addressing each system from its definition through its disposition. It must, accurately and in real time (or near real time) process data/information sets from their various sources, in their respective formats, through their many transformations and transfer media. And, most importantly, it must achieve this objective in a positive program environment. CALS is a truly challenging idea.

The CALS concept virtually requires an information flow model to show the entities and the dynamics of so broad and so potentially powerful an idea. The attached Figure 1, "General Logistic Information Model," is a preliminary effort toward graphical representation of the total CALS concept. The draft Model has attempted to follow MIL-STD-1388-1A as closely as possible. The Model consists of four main panels that can indicate the activities that may be required for the automated support of any likely logistic objective and the steps toward its achievement.

For the sole purpose of illustrating the scope of this preliminary Model, a complete but relatively small, highly adaptable, weapon system is assumed. The chosen weapon system is a multi-purpose multi-service helicopter. This system is intended to be a composite, generic product with which almost any conceivable logistic problem, analyses and solution can be represented.

In its present draft status, only the first panel of the Model, dealing with the weapon system Preconcept and Concept, is filled in. The remaining panels require appropriate functions and entities that are suggested by the first panel representation.

The activities that are performed by a wide variety of operators are listed, in Panel 1, as "a" through "ah." These operations or functions are separated into three groups--designers, resource controllers and logisticians--with an indication of the type(s) of data/information that likely are available, and the typical computer-aided technology (CAT) output of that performer.

This chart, in spite of its detail, may be too highly aggregated to be useful in analyzing a specific logistic problem. Therefore, Figure 2, "Analyses of an Individual Logistic Step" is provided. This permits selecting a small step and (1) considering the specific type of information available, (2) its format and method of data entry, and (3) the specific type and characteristics of the computer-type device employed to achieve a stated objective. Provision also is made for indicating the output information format and method, and the specific type of information output that results.

This approach is intended to provide both a general and a specific means of walking through a requirements or logistic problem and identifying graphically and, at least, qualitatively, the CALS procedures, limitations and potential remedies. A series of Model exercises, involving real products or reasonable simulations, is likely to result in "clustering" of events (problems, gaps, solutions) or resources (performers, equipments) that would help make CALS a more manageable program. Comments and suggestions toward this end are invited.

Fig 1a. FLOW OF INFORMATION in a GENERAL LOGISTICS INFORMATION MODEL

Draft 15 Oct 79
L. Dozier

1. PANEL Procurement & Concept Devel't	Initial Documentation	Type Information: Graphic	Text	Tables	Mat'l	Typical Computer aided Product
Designers	a. Design Plan (Prelim)	✔	✓		✓	- Space/Weight Allocation
	b. Reliability		✔	✓		- Target Statements/Data
	c. Maintenance		✔	✓		
	d. Human Engg	✓	✔			
	e. Standardization		✔			
	f. Parts Control			✓		
	g. System Safety		✔			
	h. Prog. Mag. Spec. Tran.		✔			
	i. Initial Provisioning		✔	✓		
	j. Testability		✔		✓	
	k. Survivability		✔			
	l. Tech. Pubs		✔			
	m. Trng/Trng Eqpt		✔			
	n. Facilities		✔	✓		
	o. Support Eqpt		✔	✓		
	p. Test & Evalk		✔		✓	
	q. New Tooling		✔			
	r. Risk Assessment (1355-14 ...)		✔		✓	
	s. QA/QC Plan (Prelim)		✔	✓		- Target Statements/Data
	t. Productivity	✓	✔	✓		- Sketches/Process Lists
Resource Controllers	u. Requirements Plan		✓	✓		
	v. Resources		✓			
	w. Calendar			✓		
	x. Funds			✓		
	y. Priorities		✓	✓		
	z. Penalities		✓			
	aa. Contract Mods		✓			
	ab. SubContracts		✓			
Logisticians	ac. Mission Needs & Alternatives Review		✓			
	ad. Design/Operational Concept Influence		✓			
	ae. Supportability Cost & Readiness Drivers		✓	✓		
	af. Support Concept Development		✓			
	ag. System Supportability Cost/Readiness Objectives		✓	✓		
	ah. Trade-Offs (LSA-101-205)		✓	✓		

2. PANEL Development/Implementation	Second Documentation	Type Information: Graphic	Text	Tables	Mat'l	Typical Computer aided Product
Designers & Fabricators	Design Program	✔	✔			- Complete Drwgs/Specs
	Reliability Program		✔	✓		- Specific Statements/Data
	QA/QC Program		✔	✓	✓	- QA Limits, Bids, NC Tapes
	Tooling	✔	✓	✓	✓	- Tool Designs, NC Tapes, Tooling
Resource Controllers						
Logisticians						

Note - Specifications are included in Design
✓ This type of information is somewhat available
✔ " " " " more available
* - information applies to this worksheet only

Figure 1a. FLOW OF INFORMATION IN A GENERAL LOGISTICS INFORMATION MODEL

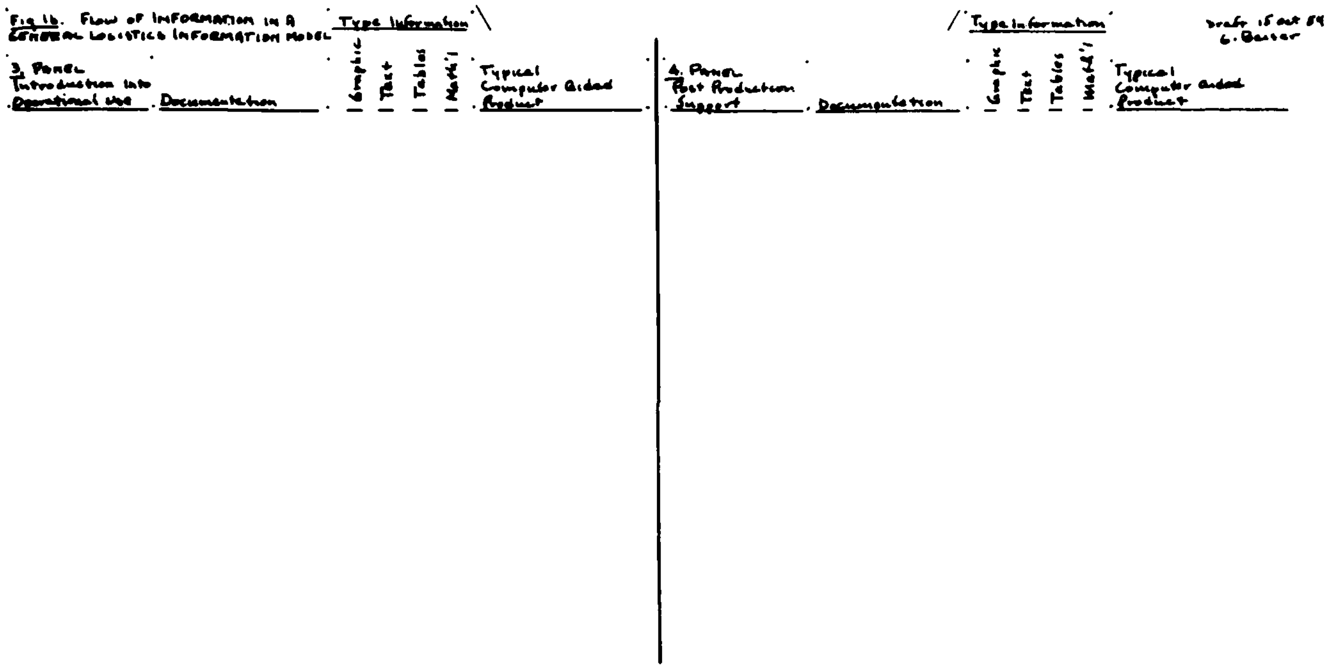


Figure 1b. FLOW OF INFORMATION IN A GENERAL LOGISTICS INFORMATION MODEL

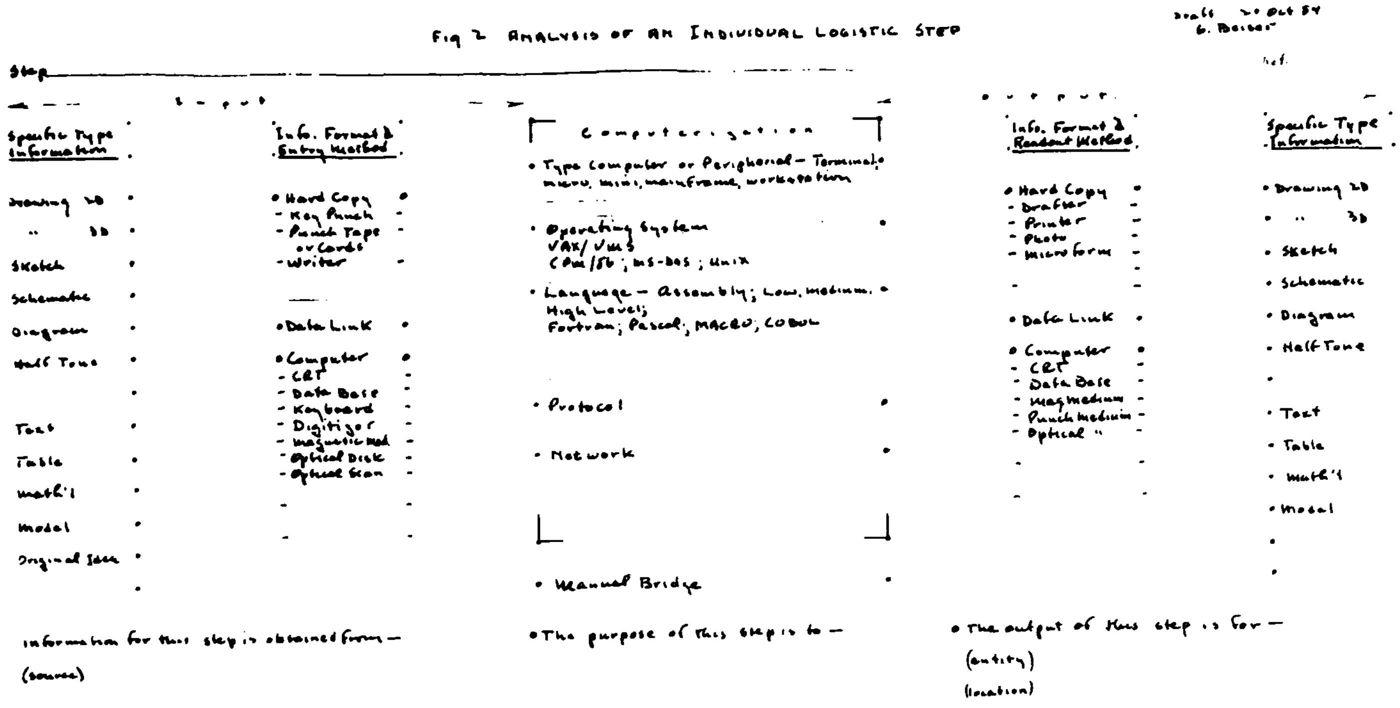


Figure 2. ANALYSIS OF AN INDIVIDUAL LOGISTIC STEP

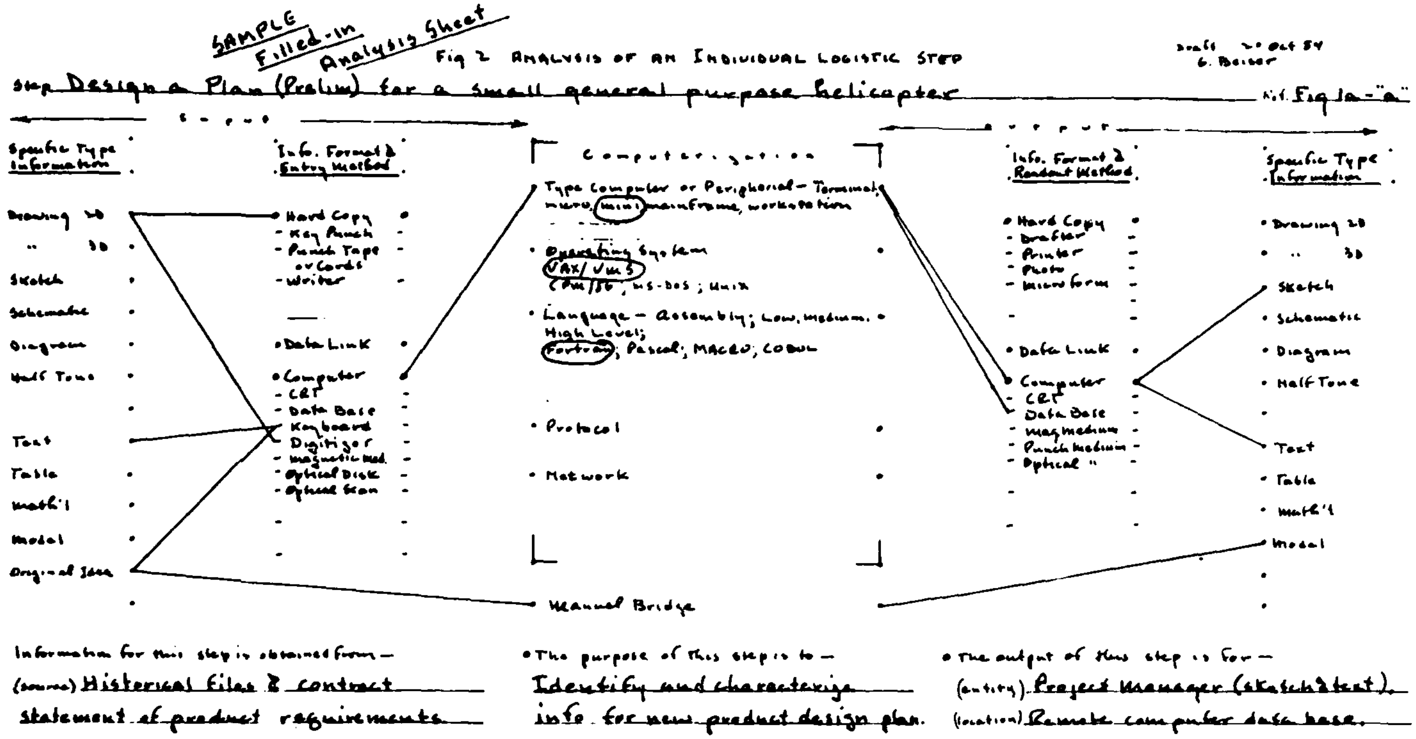


Figure 2. ANALYSIS OF AN INDIVIDUAL LOGISTIC STEP
(continued)

REPORT NO. 3

SCOPE OF CALS

SUMMARY

As CAD and CAM have widely computerized the design and manufacturing processes, providing extensive data bases, Computer Aided Logistics Support (CALS) is seen as the computerization of Integrated Logistics Support processes. CALS is the master plan affecting the activities of each ILS element organization, their interfaces with each other, with CAD/CAM, with government departments, and with contractors. Ultimately it will be implemented across all weapon systems and all four services.

Many programs exist or are under development today for automating technical information. An output of CALS is the coordination of these programs to enhance the computer aided operations. In order to implement efficiently this multi-weapon system, multi-service concept, standards are needed to define common terms and data requirements in each ILS element area. The LSA/LSAR is the mainstream analysis process upon which CALS should be built. Excellent data requirement standards are in being including MIL-STD 1388 - 1A and soon to be released -2A, while other important interface standards are in formulation, such as IGES, GENCODE and GKS.

A number of issues need to be considered in the technological scope of CALS:

- Which logistic support processes are likely to be computer assisted to most effectively implement CALS?

- How many and what types of data bases will make up CALS?
- Can data base management be independent of implementation of CALS?
- What degree of data base transportability should exist in CALS?
- What standards are needed in data base structure and what languages to aid transportability of data bases within CALS?
- What logical information model is needed for CALS?
- How much restructuring of existing data systems is required for CALS in order to accommodate required interfaces between systems?
- Will CALS be implemented in phases based on technology availability?
- What media will be used to transmit CALS information?

DISCUSSION

Before delving into the "Scope of CALS," Computer Aided Logistics Support needs to be fundamentally defined and its purpose explained. Computer Aided Logistics Support is the computerization of Integrated Logistics Support processes, just as Computer Aided Engineering is the computerization of engineering processes; as CAD is to the overall design effort; and as CAM is to the manufacturing effort.

The purpose of CALS is to increase productivity, increase readiness and support, reduce risk, and decrease cost, while, according to the DoD, providing a more manageable data base, giving the government better access to the weapon

system data base, and enhancing the post-production phase spare-parts provisioning and modification efforts.

One of the major goals for CALS is to have it tied into the basic data bases of CAD and CAM. A function of ILS is to influence the initial concept of a weapon system, and hence the preliminary design, to enhance support. It can be seen in the preliminary design stage that the logistics data base needs to be linked to the product definition process, thus providing the input basis for automating LSA, simulations, logistics assessments, etc. Alternative design approaches to the support concept will be considered based on cost effectiveness tradeoffs. Given more "real time" availability of the results of logistics analyses conducted concurrently with the design definition that evolves in the product definition data base, logisticians will have the opportunity to truly impact the design. These thoughts reflect the importance in "conceptually" reflecting support in the preliminary design phase.

The current interface between CAD/CAM and tne ILS data base is mostly manual and on paper. Some interfaces are already computerized and there are growing numbers of DoD programs researching the computerization of various elements of other interfaces. Computerized ILS and CALS is seen to include modeling, accounting, interdependency "trees," and analyses (particularly LSA).

Computer Aided Logistics Support should apply to the full depth and span of logistics activities, that is, to the ten ILS element functions as defined in DODD 5000.39. These include: Supply Support; Technical Data; Facilities; Manpower and Personnel; Packaging, Handling, Storage and Transportation; Training and Training Devices; Support

and Test Equipment; Computer Resources Support; Maintenance Planning; and Design Interface activities including Reliability, Maintainability and Human Factors. CALS should span the entire program life cycle beginning with the pre-concept phase and progressing through disposal.

In being such an all encompassing activity, CALS should be a DoD established network of data systems that establishes the mechanisms and provides the standards for the collection of all logistics related elements applicable to all weapon systems. CALS should be general and flexible enough to be applicable to all military services' and government contractors' logistics requirements.

The mechanisms for supporting CALS should include all the data bases, computers, communication linkages, recording media, software, etc. necessary to provide compatability among the participating contractors and services. CALS must be responsive to activities performed by the producing activities including the System Program Office, the Air Logistics Centers and the Government Laboratories. CALS must be compatible with the activities including operational units and the associated support activities at all levels.

Although it might be possible to have a centralized computer, data base, etc. to support CALS, it would probably not be very practical. If the services/contractors did not necessarily use the same mechanisms to support CALS, these mechanisms would have to have a certain amount of standardization/compatability to permit transportability of the various data elements and permit communication between the participants. This leads us to one of the major challenges, namely, developing a comprehensive set of standard data

definitions for commonly used logistics parameters. One suggestion is to build upon the existing Data Item Descriptions to achieve this commonality of parameter definitions. A DoD Directive (similar to 5000.39 perhaps) should require the establishment of a military standard (similar perhaps in intent to MIL-STD-1388-2A) that would establish data element needs, define data element formats, define necessary interfaces with existing systems and future systems, define applicability to various weapon systems phases, define system coordinating agencies, etc.

CALS should consist of information data bases and expert systems (including artificial intelligence). In developing CALS, the following technical issues should be included:

- Application of embedded computer resources (computers, software and firmware) in weapon systems.

  Breakthroughs in microelectronics make possible smaller and faster computers that will expand the use of embedded computers in future weapon systems. Embedded computers will have a long range impact on both the operation and logistics support of weapon systems. CALS must interface with and support these embedded systems. Techniques for influencing the design of software and firmware will be different from that of conventional hardware. Maintenance and support of embedded computer resources will also be different from that of hardware.

- Solid state technology using firmware in lieu of software.

- Teleprocessing (combined use of communications facilities and data processing).

  With computer costs dropping, the widespread use of microprocessors is making the transfer of information more economical. Teleprocessing is also aided by advances in VLSI, digital techniques, satellites and optical fibers.

- Standardization of higher-order languages and architecture of interfacing systems.

There are many programs in development that revolve around automating logistics data bases. These include the Air Force: ATOS, EDCARS, MIDAS, IDS, ICAM, CIM, IMIS, GIMADS, and LIMSS. For these to be widely used by multiple commands and contractors, communication networks such as DDN and LAN must be fully developed. The Army and Navy also have many such efforts. For these programs to eventually evolve into CALS, considerable government support will be essential and contractors must be provided substantial incentives to invest in the added automation.

The scope of CALS must be broad enough to encompass these multiservice programs and ensure the standardization of their basics while relaxing on the "how to," particularly when affordability/low costs dictate. To achieve this multiservice system approach, cultural and "rice bowl" barriers between the functional specialty groups in the DoD acquisition establishment must be broken down. Industry will then follow.

The evolutionary approach will see the coordination of the many existing programs and increasing application of the pilot programs. These, by economic necessity, will be incorporated in new weapon system programs and gradually

expanded across the services. Thus a long term program is expected, as represented in Figure 1.

Prepared by ILS Department
For Fred Macey
Lockheed-Georgia Company
October 1984

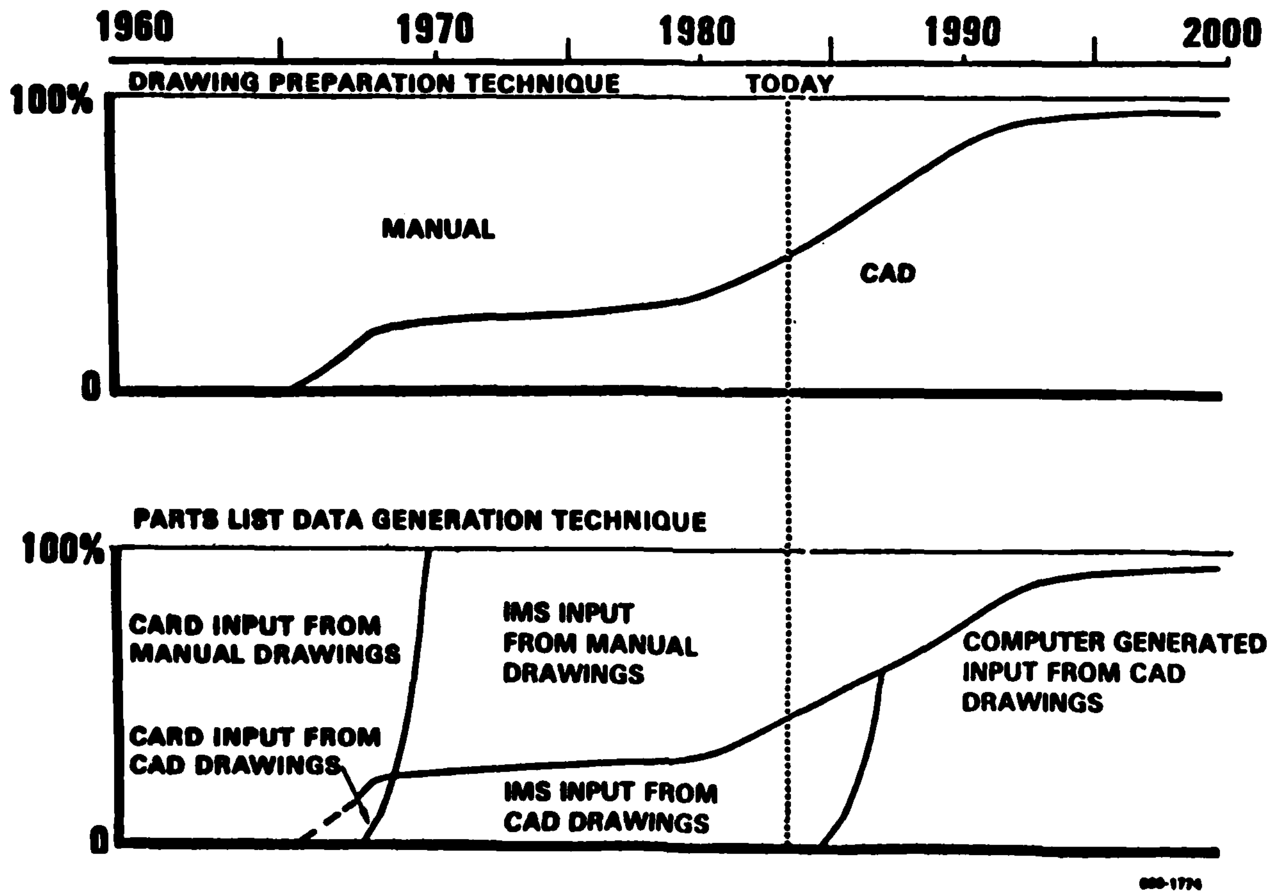


Figure 1. AUTOMATING THE GENERATION OF THE PRODUCT DEFINITION DATA BASE

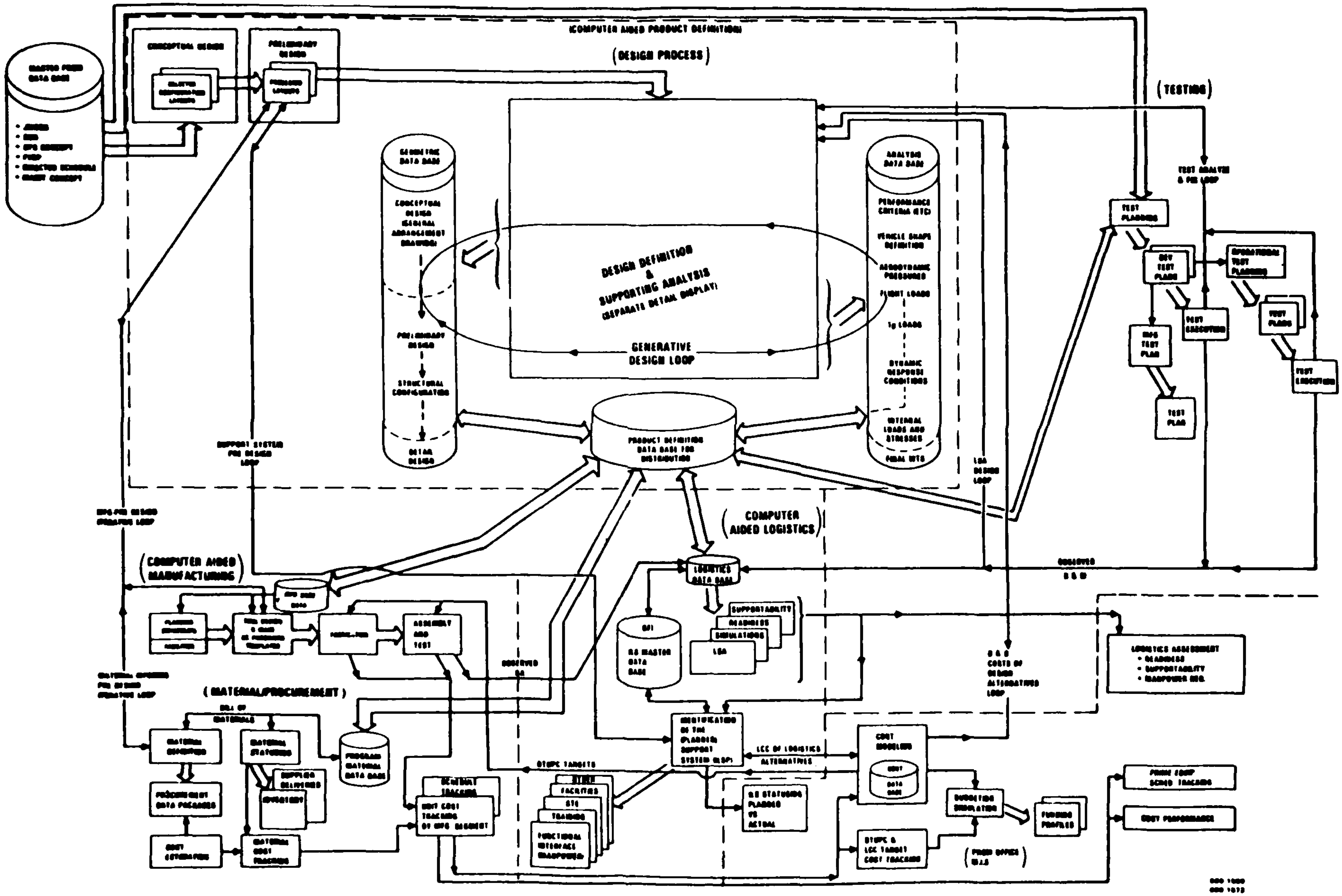


Figure 2. COMPUTER AIDED TECHNICAL MANAGEMENT

REPORT NO. 4

COMPUTER AIDED LOGISTICS SUPPORT (CALS)

COMPUTER AIDED LOGISTICS SUPPORT MUST BE ORIENTATED TOWARDS THE DESIGNER'S USE AT A POINT WHERE THE CRUCIAL AND ROUTINE DESIGN DECISIONS ARE MADE. THE CAD/CAM OFFERS THIS CAPABILITY.

Advances in computerized techniques and hardware, along with the development of shared and on-line data base systems have made design for supportability a reality. Research in defining and quantifying supportability has led to the potential ability of the designer to interact with the supportability engineer in a user friendly environment in sharing each other's knowledge. This shared approach may be typified by a computerized workstation that permits development of top level and detailed Supportability Design-to-Requirements (SDTR's), and translates these to the designers via the CAD/CAM. Some of the considerations that should be addressed are given below.

A. PAYOFF

1. The Measures of Effectiveness (MOE) for the various weapon systems are a function of the mission. Thus, a cargo aircraft would be different than a fighter, and as a corrollary so would be its respective design features. In general, sortie

generation capability in a sustained mode under war time conditions is a critical MOE. The payoff is then the ability of the weapon system to counter the threat with a reduced force size. Because more aircraft are available for combat, the payoff can be the ratio of typically required aircraft versus those capable of the increased capability "to fight again."

2. The immediate introduction of supportability in the design concept formulation phase requires a slightly larger investment in supportability engineering, but certainly far less than the offset in FSED through ECP activity. Another payoff is the fact that a smaller supportability staff is needed because with the proper tools more efficient use is made of information during the intense proposal activity by government and contractor alike.

A payoff overview is provided by the following matrix:

PAYOFF OVERVIEW

	NEAR TERM	FAR TERM
GOVERNMENT		
Reduction in Analysis	X	
S in Acquisition Process	X	
S Specifications	X	X
KELSA Efficiency	X	X
INDUSTRY		
Supportability in Weapon Systems		X
Lower LCC		X
S in Acquisition Process	X	
S Specifications	X	X
KELSA Efficiency	X	X

3. A shared methodology between government and contractor provides numerous benefits such as: data compatability, increased communications and almost real time analysis. Using an existing enhanced LSA, the additional supportability parameters are analyzed through the "Use Study, Task 201" and "Comparative Analysis, Task 203." This process not only determines the needed supportability parameters for consideration of a new weapons system, it also provides feedback during the entire engineering process.

4. Payoff to DoD would be to make S as important as performance, and will result in greatly reduced O&S cost by affordable acquisition cost, since S incorporation is by competitive bid for FSED instead of sole-source ECP activity.

5. Industry would be in a better position for true competition and finally get the funding up front to incorporate S in design.

B. INCENTIVES

The use of incentives will provide the impetus for a more intense contractor response and the pattern evolved from the successful F/A-18 program should be considered. The inclusion of specific SDTR's in specification language will give each contractor inherent incentive, since specifications are within the engineering domain and objectively analyzed.

C. TASKS/PROBLEMS TO EXPAND CAD TO INCLUDE SUPPORTABILITY ANALYSIS

1. Hardware - The hardware for the Computer Aided Enhanced Logistics Support Analysis (KELSA) uses the IBM 3081 mainframe and IBM 3278 and 3279 terminals. It is possible to obtain emulators for the IBM terminals which would interface with the mainframe. Use of various peripheral models can be made on personal computers which are down-loaded into the mainframe. Word processors that are compatible with the mainframe help reduce tne workload with regards to loading data bases with text and numbers. The CAD/CAM terminals in use today that are running the CADAM software would be most compatible with the KELSA software.

   The problems of expanding KELSA into the CAD/CAM environment are essentially not hardware related but are mainly of the software type. Interface devices may be a means of directly interfacing the KELSA with CAD/CAM, and this is currently being investigated. As already pointed out by the IDA panels, the issues of standardization and communication media requirements will dominate this area of growth. A workstation approach permitting the designer and the supportability engineer would enable each to work efficiently and within an ideal communication environment when linked through tailored software.

2. Software - The KELSA is written in PL1 and uses peripheral models that are written in FORTRAN. The challenge confronting the linking between

the unique CADAM type language and those of the KELSA is the main concern. Particularly, the designers need only know those technicalities directly affecting the design process -- design information must be "transparent" and address all levels of the weapon system indenture level.

3. <u>Data Bases</u> - The primary data required for KELSA is the weapon system performance through systems such as the Automated Maintenance System (AMS) at Dover AFB, Delaware; the Maintenance and Operational Data Access System (MODAS) from WPAFB, Ohio; the Visibility and Management of Operations and Support Costs (VAMOSC) also at WPAFB, Ohio; and the Naval Aviation Logistics Data Analysis System (NALDA).

Although much of the data concerns itself with labor and management reporting there are specific data elements that provide design relatable information. It is the area of design relatable information that must be addressed in the formulation of new data bases. However, this writer's opinion is that most of the necessary data elements -- a combination of detailed operational and maintenance data -- already exist at DAFB. The problem exists in that existing models use data elements that are derivations of the collected data elements. This derivation process leads to ambiguity, assumption and data bias. Continued research is necessary to close the gap between the data requirements of the logistician and the designer.

4. <u>Parametric Analysis</u> - As a result of the necessary design parameter orientation of future data bases, it should be relatively easy to assemble and catalog design elements that can be used in modeling such as early parametric analyses. The need for such parametric analysis exists in the conceptual phases where supportability requirements can drive the decision between an aircraft with "podded versus embedded engines" as an example.

5. <u>Issue</u> - DoD should encourage industry to specify <u>S</u> for competitive evaluation by use of specification language as a new output of the LSA. Tailored <u>S</u> specification language would eventually be part of the Statement of Need (SON) for each type of acquisition.

6. Use an overall <u>S</u> plan approach that will achieve 1st, 2nd & 3rd generation of CAD from the broad base of SDTR's/specifications with KELSA enhancements to the LSA process.

7. This first generation broad base capability has been demonstrated to be an acceptable tool for the advanced design organizations in one company to use on CAD to achieve the 2nd generation level. The front-end <u>S</u> analysis process used at Lockheed provides the basis for artificial intelligence since it is built on use of logic that can be developed into artificial intelligence.

D. ADDITIONAL CONSIDERATIONS

- Selected Candidate Weapon System
- "Intended use"

- Design for S Baseline
- A/C Characteristics/Features
- Data Base of SDTR's for above
- CAD Graphics
- Quantification of SDTR's
- Graphic representation of tailored SDTR features
- Tailored SDTR's for System Specifications

Technology

- Data Bases (UDB, MODAS, etc.)
- KELSA
- Design for S Handbook with tutorial screen approach
- Development of logic flows for S on CAD that can lead to artificial intelligence.

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October 1984

REPORT NO. 5

ISSUE:
SUPPORT OF CONTRACTOR/DOD DECISION PROCESS

via

- AUDIT TRAIL
- MANAGEMENT OF CHANGE

Throughout the acquisition process, decisions are made by contractors and DoD agencies that: establish alternative courses of action, select the optimal alternative, establish plans for accomplishment, and affect details of implementation.

This decisionary activity is an iterative process from the preconceptual stage through all program life cycle phases. Each decision is the result of some form of formal or informal trade-off analysis based upon the "best information available" at the time the decision is made. Unfortunately (and fortunately), the "best information available" is an information set from some data base(s) that constantly changes. Hopefully, the changes are improvements in quantity and quality.

Paradoxically, however, the constantly changing data elements can work both for and against the decision process. Working for the decision process is relatively straightforward: improved timeliness of more quantity and better quality of information results in higher quality, better-informed decisions, all else being equal. Working against the decision process is more subtle. For example, the information set upon which a specific decision is made may be irrevocably altered with new data, thereby rendering the decision result

virtually impossible to reconstruct. The audit trail disappears -- which may or may not be important for future decision making.

Therefore, this technical issue involves determining the requirements for controlling and recording results of the decision processes that establish content and use of digitized information in a complex and dynamic data base.

Any substantial data base, centralized or distributed, should be thought of as a virtual living entity. The data base for an active program or equipment will be continuously changing and, in most cases, growing. If, as envisioned, the data base is utilized in a paperless scenario, the magnitudes and rates of change and growth will be virtually invisible to the user. Indeed, the mere fact that the information in the data base is changing may not even be evident to the user . . . nor, maybe, should it be. All the user is interested in is readily obtaining the information he needs in a timely manner, whenever he needs it, and with confidence in its accuracy and completeness. Therefore, when user A uses information set I from data base DB at time T1 to make decision D1, he (and any other user) should have the ability to retrieve the identical information set 1 at times T2 and T3 even though data base DB will have changed to data base DB' or DB''.

The central questions are: 1) How do you establish and maintain an audit trail in a dynamically changing data base, especially where the change is invisible to the user? and, 2) How do you effectively and efficiently manage the magnitude, frequency, scope, content, extent, etc., of change?

A simple analogy is offered to better understand this issue. Consider a single engineering drawing of a widget. It starts out as a "no change" vellum from which drawing copies are made and from which 'widget-NCs' are manufactured. Then an engineering change is made that makes the widget more reliable. A drawing of 'widget-NC' is put on file, and the vellum is altered to reflect "change A," the more reliable 'widget-A.' 'Widget-As' are then manufactured. Then changes B, C, D, etc., occur and their corresponding widget configurations are manufactured. All configurations of widgets are in active use and require servicing and maintenance. The engineering drawing vellum reflects only the latest widget configuration, but copies of all prior widget configurations are stored in an engineering data center. This procedure constitutes a simple form of management of data base (the engineering drawing) change, and establishes and maintains an auditable trail of change history.

While the nature of the digital data base is quite different, the requirement to maintain multiple configurations of a device and to manage the changing data base does not change. However, the question of 'How much is enough for a proper audit trail?' becomes more prominent. When does the amount of additional data required in the data base exceed its benefits? When does the change management function become too burdensome?

Consider the case of the widget drawing in a digitized data base. The engineering drawing in its "no change" configuration is represented by, say, X Kbytes of information. If "change A," the reliability change, affects and changes 10% of the X Kbytes, will the audit trail require 1.1X Kbytes of storage (the original "no change" configuration

plus only the 10% that has been changed), or 2.0X Kbytes of storage (the original "no change" configuration plus the complete "change A" configuration)? If, additionally, changes B, C, and D each also affect 10% of the 'drawing,' will the computer storage requirement be 1.4641X* Kbytes or 5.0X Kbytes? (Assumes <u>only</u> <u>changes</u> but <u>no</u> <u>additions</u>.) The potential impact of audit trail requirements on computer storage capacity is enormous. Even for this simple example of four changes, each affecting only 10% of the latest 'drawing' configuration, the maximum/minimum storage requirement ratio is approximately 3.4. Projected to hundreds of thousands of drawings and documents, and the requirement for multiple configurations of each drawing and document for audit trail and other purposes, the mere data storage issue is mind-boggling. And when data <u>additions</u> (not merely changes) are considered, the issue becomes even more complex.

The problem to solve in the 'digital world' is to manage data change so as to drive and keep the maximum/minimum data storage requirement ratio as close to 1.0 as possible while retaining the flexibility to satisfy the users' needs.

The storage of widget configurations in the 'paper example' corresponds to the maximum (5.0X Kbytes) condition in the 'digitized example.' Each drawing configuration paper copy reflects both changed <u>and</u> unchanged information. In the 'paper world' this repetition and storage of unchanged information, while not desirable, may be the only practical method of maintaining an audit trail. Not so in the 'digital world.'

* 1.4641 = (1.0 x 1.1 x 1.1 x 1.1 x 1.1)

However, the 'widget example' addresses only the storage of data on the end item, i.e., the results of decisions. Is this sufficient to produce an adequate audit trail, or should the rationale behind the changes also be stored? Should the reasoning used to formulate a decision that results in change to an end item (drawing, document, etc.) also be stored in the data base? If so, how much rationale is required? What constitutes sufficiency or adequacy for the audit trail?

ACTION RECOMMENDED: (to support the decision process)

1. **DEFINE REQUIREMENTS FOR A DECISION AUDIT TRAIL.**

   How much data is needed to support the decision process?

   Is it adequate to store only results of decisions, or is there also a requirement to record and store the rationale or reasoning for arriving at the decision results?

2. **DEFINE REQUIREMENTS FOR MANAGEMENT OF CHANGE.**

   Recognize that, even with current and projected storage capacity capabilities, everything cannot be stored. What are the limits for supporting the decision process?

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Hughes Aircraft
October 1984

REPORT NO. 6

LIMITS ON DOD ACTION

Limits discussed here pertain primarily to the extent to which DoD invokes new requirements and developments, as opposed to adapting existing and ongoing capabilities for the construction of CALS. The areas discussed are summarized as follows:

Standards - DoD should take an active role in shaping, developing and validating existing international standards to be sure that CALS needs are accommodated and that CALS is structured to those standards.

Implementation - Strict contractor compliance to CALS requirements should be demanded and validated, but contractors must be allowed to implement CALS consistent with corporate information structures. Similarly, users should be allowed a wide range of processing, storage and display choices as long as compatibility with CALS is achieved. DoD may wish to sponsor and fund CALS hardware/software packages and offer them to contractors and users in order to limit government costs.

Networking - CALS should comply with mandatory use of DDN as the backbone network for all DoD users. Considerable investment will be needed to expand capacity and extend DDN to thousands of government and contractor vendor locations. The use of commercial networks linked to DDN should be considered, consistent with security needs.

Security - Transparency in authenticating each query, and in routing between supplier and user is key to the CALS concept. Rather than burden each supplier and each user with cumbersome procedures and lists of authorized participants, these functions should be performed by several government-operated CALS "Control Centers."

Flexibility - Supplier responsiveness must be required on a flexible scale. On-line data storage should afford response times in the order of seconds, or, for large data requests, overnight. Archived data, and non-automated data such as microfilmed drawings, should afford delivery in days or weeks.

Proprietary Information - Much design data is considered proprietary. Contractual regulations exist to accommodate this situation, and changes are being considered to address rapid electronic technology turnover and post production support/diminishing manufacturing sources issues. CALS should not attempt to solve these questions but should accommodate the contractual regulations. CALS is likely to influence negotiations on what data really must be labelled proprietary.

Detailed discussion of these areas follows.

Standards

Numerous standards applicable to CALS exist, or are being developed and expanded. This includes standards for data format (IGES et al), interface protocols (ISO 7-level), data elements (MIL-STD-1388, DoD-D-100 et al). It is difficult to imagine that DoD requires any

data via CALS that is significantly different or unique from the needs of at least some other users on the international scale. Some tailoring may be necessary to adapt such standards to CALS purposes, and their development paces may be slower than CALS requires.

However, it would be foolhardy (for both time and cost reasons) for DoD to undertake development of any new but duplicative standard, and then expect contractors to comply with both the CALS-unique standard as well as the comparable standard the rest of the world demands.

What DoD should do is take an active part in shaping, developing and validating the international standards to be sure that CALS needs are accommodated and that CALS is structured to those standards. Infusion of DoD and industry technical expertise and funding into the work of selected standards committees may be the catalyst needed to accelerate the developments and to accomplish validation for CALS purposes. Such involvement should have the equally important objective of assuring that revisions of a standard are compatible with earlier versions, so that CALS users of any generation can access data structured to contemporary as well as older generations.

Implementation

As CALS information suppliers, contractors must be allowed to implement CALS compliance consistent with corporate information structures. Strict compliance should be demanded and validated for (1) delivery of all information in standard format and content, (2) when and where requested, and (3) with archival permanence. But the contractor should not be fettered

with detail requirements on data base structure and management, computer and storage hardware, software language, CAD/CAM system, and so on.

This seems to imply that each contractor will have to develop translators to convert his unique implementation to CALS. In the short term, that is likely to be true but is not inordinately burdensome because most modern corporate information structures possess inherent flexibility and at least partial compatibility with standards, such as IGES and ISO interface protocol. A market will evolve for software specialists to develop such translators at reasonable cost.

In the longer term, it is very likely that software specialists will market general purpose or tailored turnkey packages that might encompass not only CALS requirements but also major portions of internal corporate information needs, in much the same way that MIL-STD-1388 has spawned numerous and progressively more capable LSA software packages. DoD may wish to sponsor and fund such a package and offer it to contractors in order to limit government cost. Each contractor then could choose to use it in toto or in part, tailor it, or develop a unique package. Contractors are willing to share with DoD reasonable investments in this area in the expectation of a return based on increased productivity, and to limit the intrusion of DoD into corporate information structures.

CALS users should be expected to have local (if not private) data processing and storage capability. "Dumb" terminals should not be serviced directly by CALS. This is a reasonable constraint because products,

products, such as personal computers, will continue to proliferate as cost declines and capability increases. Such local capability will be sized to the data needs of the user who will have his own local data base. This will have the very practical effect of minimizing network capacity, and reducing user dependence on a CALS network that is subject to pre-emption for command/control during stress or to disruption by hostile action.

Because of wide variation in user needs and rapid advances in products, CALS should not mandate a specific user workstation. DoD may wish to sponsor a family of commercial or military workstation devices and software, but should not exclude other products that can be made compatible to CALS. Special workstations, such as portable displays for flight line and field maintainers, should be compatible with CALS but should be developed for specific weapon systems or as service-wide projects apart from CALS.

Networking

The Defense Data Network (DDN) is mandatory for all DoD users as the backbone network (secure and non-secure).* CALS should comply with this policy, but considerable additional funding to expand transmission capacity and add terminal access will be necessary. Funding is currently provided by tri-service shares rather than direct charge to each new user. Hardware delivery and installation delays are likely to be a major problem.

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*OSD policy statement 10 March 1983

Contractors are connected to DDN if sponsored by a government agency. However, no clear policy has yet been established for interconnections between DDN and commercial networks. CALS may be unable to justify the cost of extending DDN directly to thousands of individual contractor and government locations. Some strategy is necessary to allow contractors to connect to DDN via private or commercial networks or other government networks.

This would ease the burden on DDN expansion by transferring much of the burden to commerical networks which have shown, and can be expected to continue, a willingness to respond to rapidly increasing demand for services. Initial investment is recovered in time via subscriber usage billings, which will have to be considered in CALS funding.

However, security risk from "hackers" or more deliberate intruders gaining access to DDN must be considered. The user-authentication protocol provided at each DDN gateway and terminal access controller must be reviewed for adequacy in managing the added security exposure. In addition, adequate encryption of classified CALS data for transmission over commercial facilities must be considered.

Security

Security against unauthorized access and for integrity of the data base is a growing problem for information automation in general, no less for CALS. Most strategies depend upon the information supplier to

demand from each user adequate identification via suitably complex passwords, together with physically secure transmission facilities or data encryption.

DDN provides military-grade encryption at designated ports for classified traffic and normally routes such traffic over dedicated facilities. Separate facilities carry unclassified traffic and employ the commercial Data Encryption Standard for CONUS traffic and military-grade encryption overseas. NSA gateway devices allow classified traffic to use the unclassified network in times of stress or emergency.

DDN appears to contain inherent security measures that are adequate for CALS communications but, like most "public" networks, does not address the issue of supplier-user authentication, which is traditionally left to each subscriber to resolve. Conventional measures require a typical data base owner (i.e. the prospective CALS supplier) to maintain a list of authorized users with appropriate authentication codes. Any CALS user with a-need-to-know should have access. But the world-wide list of such users for a major weapon system could number in the thousands and change daily. Expecting each data supplier to maintain a current list and enforce confidentiality of authentication codes poses a security management nightmare.

Conversely, expecting each user to maintain a current file of data suppliers for all of the equipment and parts under his purview for use in addressing and routing a transaction is unrealistic. DLSC presently maintains such a file that could be adapted to CALS.

Transparency between the user and the ultimate supplier is the key to the CALS concept. Both the security and the routing transparency issues suggest a "CALS Control Center" concept through which all queries initially flow for authentication and proper routing. Several regional Control Centers would contain a current matrix of authorized users for each supplier, and would perform necessary authentication and routing procedures. Actual supplier-to-user data transfer may bypass the Control Center once these procedures had been completed, in a concept analogous to a telephone switching system wherein complex "intelligent" equipment is involved only briefly in interpreting the call parameters and setting up the physical connections.

Flexibility

Supplier responsiveness must be required on a flexible scale. High usage and/or critical information (such as maintenance procedures) may justify query responsiveness on the order of seconds, but the cost of on-line storage, processing and transmission capacity must be considered.

Most current data will be accessed infrequently so that overnight retrieval and delivery should be adequate. Archived data (such as reprocurement packages for out-of-production equipment) is rarely accessed so that query responsiveness on the order of days should be adequate.

Provision should also be made to place requests via CALS for non-automated data (such as hard copy drawings from small vendors who choose not to participate in CALS automation. This can also be applied to existing

data which does not justify the cost of automation, as well as data generated during the transition phase before CALS completion).

In any case CALS should inform the user for each query the expected response time and the delivery medium (e.g. telecommunications, floppy disk, mail). Should a specific query demand shorter response time, CALS should be capable of invoking priority procedures (at a suitable increase in cost to the user).

Proprietary Information

The CALS data base should contain all necessary data to define the end product, by either the original manufacturer or a second source at any time in the future. Some key rationale that substantiate the particular design solution should also be part of the data base to permit someone other than the original designer to make changes in function or to reduce cost, or to adapt for newer manufacturing processes.*

Much of this design data may be considered proprietary. This is nearly always true of new or highly competitive manufacturing processes, especially the integrated circuit community with its VHSIC/VLSI processes. As long as a vendor continues to manufacture an item, contractual regulations have been in use for many years to accommodate these situations. However, when the

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*Design rationale should be part of design reports, but often resides in obscure engineering notebooks. CALS itself should not mandate the publication of such data, but should afford means to store the data and provide pointers to relevant reports.

vendor ceases production and support, reprocurement is much more uncertain and costly, unless the government has purchased the proprietary data. Even then manufacturing processes may be unique to that vendor, and may still be considered proprietary for other items of his product line. DoD is currently focusing attention on strategies to cope with post-production support and the related diminishing manufacturing sources problem. CALS should not attempt to solve this tough problem, but should be capable of accommodating whatever solutions are implemented.

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IBM Federal Systems Division
31 October 1984

REPORT NO. 7

POINTS FOR HIGHLIGHTING IN THE CALS REPORT

Here I bring to your attention 11 points which I think should be highlighted in both the TECHNICAL ISSUES and, consequently, in the CALS Reports:

1. GENERAL

The main purpose of logistics — roughly — is to fix what was not properly designed, manufactured or maintained, and to replenish consumed materiel. The main goal of the CALS Program — at least in its initial phase — is to give a fast start to a strong supporting computerized environment, which would stimulate automation initiatives within functional codes, and also to provide special purpose tools to functional codes (i.e., turnkey logistics workstations, or logistics application software packages) which will improve performance of logisticians. This as a payoff will help to resolve technical problems of lagging productivity in Defense logistic systems, and subsequently will help to improve DoD's <u>industrial base</u>.

Three major factors, as I see it, are playing a role here: unification, data management, and networks.

In attacking the CALS issues and approaching the execution planning we have to consider the following experience gained in development of other large systems.

- Overcollecting data, including multiple reentry of data;

- Overdesigning products in attempt to cope with unknown;
- Underestimating support (variety and cost);
- Underestimating psychological barriers (i.e., drawing authentication);
- Overcontrolling systems by the traditional hierarchy of organizations due to a limited human capacity;
- Underestimating continuous drifting apart of products in service and enabling technologies;
- Attempting to solve somebody's problems in lieu of ones own.

It can be concluded from this list that there is a need to analyze department by department, workfunction by workfunction ("walk through") regarding how much and what kind of technology is involved and will improve the performance of a product and the performance of product supporting operations. Information engineering is to be applied after that. Documentation of this kind should be the No. 1 priority in CALS group's planning.

2. BASIC ISSUES

Scope of basic issues remains the same: technical, managerial, financial, and legal. All technical issues in general are caused by a conflict between the knowledge needed to provide material required by contemporary defense systems and ancient techniques of providing such material. Accumulated expertise in data communication and data processing technology now allows

incorporating advanced computer-aided techniques into conventional logistic execution methods, developing new methods and extrapolating these new methods into the future defense logistic procedures. In addition to technical issues which were discussed and published during four CALS sessions, and with reference to the above there is a need to emphasize the following:

- Data communication issue. It seems important to partition the communication issue into three separate categories: (1) communication supported by a single uP in a relatively small organization; (2) communication supported by a number of microcomputers in a relatively large organization; (3) communication among variety of organizations. Each of these three categories would have its own quite different issues to address, but in a hierarchical order.

- Geometry vs. text issue. A critical problem in communication is the lack of understanding of the meaning of a drawing. A drawing is required to assure compatibility of three ingredients: Customer system, Vendor system, and Manufacturing system. Digital representation of a drawing allows rapid extraction of information for plotting/drafting a part, for engineering analysis of this part, and for manufacturing this part. There are numerous software packages which intend to do that. At

the same time there are no programs that would extract a part from an assembly drawing if only the part number is given, or answer a query without human intervention, or recognize a part or its features on the basis of jargon definition. These capabilities are the most needed in logistic support. So the text and geometry integration is a very important initiative which will help to overcome the communication barriers.

- Expert systems. Enabling technologies and products in service are drifting apart during the lifecycle of a product. It is obvious in the electronics supply and in Naval ship maintenance activities. Expert systems are envisioned as playing a substantial role in the process of adding, recovering or replacing human expertise in parts restoration and other repair needs.

- Process models. Documentation models need to be incorporated into a logistic process model. Virtual processor concepts can be used in developing the acquisition process models.

- Economic justification. ROI is difficult to justify. Conceptually new methods of justification are to be provided.

3. STANDARDS

Standards in their unique role as DoD standards imply "the best out of many," not just an overregulated "only." They are some of the solutions to the CALS task, not a CALS supposition. They will derive as a result of CALS strategy, of its implementation policy. On the other hand they are not yet standards! They are proclaimed as standards, they are written in a form of standards, because we want them to become standards. But, what they actually are — they are proposals for unification of protocols, formats, etc. They will become standards after a majority (say, 60% or more) of CALS/CAD/CAM/CAP community would conform to them and use them in an orderly manner. The action of standardization should be executed cautiously: extensive military control resulted in a reluctance of 90% of commercial business to get involved in military production.

- GENCODE & IGES, Graphics specifications. The following diagram illustrates the relationship between applicable graphics hardware/software specifications. The unification around graphics and text can have a clout in standardization effort, but the need for unified techniques in dozens and dozens of other related processes should not be overlooked:

WEAPON DB

IGES level

APPLICATION PROGRAM

GKS, PHIGS level

GRAPHIC UTILITY SYSTEM

VDI, VDM level

DEVICE DRIVERS

NAPLPS level

VIDEO DEVICES

The text markup unification is essential, no doubt, for training and assembly manuals, but the most important and effective suggestion would be to expand GENCODE, the text markup specification, into drawing areas — for Bill of Materials (BoM) markup. BoM standards are needed independently, though.

- o MIL-STD-100C et al. via its drawings of a product "hardware" determines communication quality among three communities: users, vendors and producers. This mylar-based product definition unification needs additional regulation in time of transition to knowledge based systems. Support for modification of DOD-STD-100C is needed.

- Transition period. Transition period requires an understanding and support of all three communities. Transition period in every technological change causes uncomfortable feeling of uncertainty. Duplication (i.e., two carriers — mylar and magnetic tape) or redundancy — is an unavoidable price for reliability, choice of solutions, ease of transition, etc. Thorough training of personnel in combination with expert software systems might serve here very well.

4. DATA BASE

We have to emphasize continuously that data bases themselves are unable to bring order into the real-life data chaos. It is good to show that data is primary, and that a data base is secondary. Data type, data structure, data flow, data management, data transfer, data reliability, destruction/aging and data refresh, etc. — have to be studied and understood before anything else is proposed for execution. An efficient data management system cannot be a stand-alone, it is to be supported by widely dispersed CAD/CAM data automation and office automation systems of first, second and even third tiers. When in a critical path or in a scheme or sequential (presumably, automated) processes of acquisition and a single process is slow (say, manual) — then the entire acquisition will be dependent on this manual process, and efficiency will be dragged down by the inefficiency of this manual process. A data base is, roughly, a filing system, therefore, it should be addressed by the Systems Architecture Subgroup. DBMSs are designed to operate

these files, therefore, they should be addressed by the Information Requirements Subgroup. There are no graphics fields in the PC's data bases, so when a data base for a logistics workstation will be specified it should include graphics fields.

5. NETWORKS

Conventional networks in their telephone and telecommunication versions were designed for interactive short messages communication. The two following characteristics of DDN should be considered when CALS network is proposed: DDN will take file transfer in packs; DDN won't support CAD/CAM's 3D solids representation in interactive mode. I/O devices are projected to be a limiting factor.

6. TURNKEY CAL WORKSTATIONS (WS)

Workstations will play an increasing role as the CAD WS played in design. It might need a large variety of functions because of high diversity of logistic disciplines. Its utilization has to be programmed accordingly. Notice that out of 12,000 companies using computer graphics for CAD and engineering about 80% are using only drafting with little or no design.

7. FEEDBACK

There are many examples of systems that failed because they provided a forward control only. Provisions for the formal feedback (programmed, structured, continuously fed, and analogous sensory), along with the informal (unstructured, spontaneous, sporadic) feedback need to be included in CALS Report.

8. ACCESS CONTROL

This topic should be given a deeper meaning than just an access control. It should be interpreted as a part of access management. This access management is to be treated as a separate CALS concept. It is required to stimulate access, stimulate exchange and creation of information, not just to prevent undesired access. Thorough personnel training is to be devised.

9. CALS PILOT PROGRAM AND DEMONSTRATION.

Principles and ground rules: (1) multiple team approach (example: ITA project administered by DARPA) which provides an expertise and a base for discussion and solution selection; (2) it cannot be a stand-alone (as a reef of automation), it is heavily dependent on interaction and support from a large network of subcontractors, vendors and concerned agencies; (3) its building elements should not be unique, only specific logistic procedures can be unique; (4) an industrial experience has to be considered: KANBAN, the just-in-time inventory control system (Jap.); Kawasaki (Toshiba Tungaloy plant); Nijigata; Messershmidt; Rolls-Royce; GE's Motor frame manufacturing; TI's business and CAD/CAM logistic support system; ICAM (an AF program); IPAD (an AF and Navy program), etc.; (5) it must start from emulation on a model; (6) it must be correlated in the length of time with the stochastic property of failures and life cycle of a selected product; (6) the best result of experimenting and demonstrating on large systems can be obtained if to start it from a headquarters, because: (a) HQ has less boundaries, and (b) proliferation of the developed methods downward should go smoother and more natural.

10. INTEROPERABILITY

It depends on and includes transparency of operating systems, application software, product data definitions, data files — to users (organizations and operators), hardware (uP, I/O, and network). This is the prime arena where the system of standards is a must(!).

11. ASSUMPTIONS

When assumptions are made the realism is sacrificed. Therefore, a minimum number of assumptions explicitly formulated and agreed upon is a must for this project. They may include such hypotheses as:

- Logistic organizations are flexible enough to adopt structural and functional changes imposed on the organizations by an aggressive computerization program.
- CALS represents a completely new environment where we cannot learn from the past and are pioneering.
- The errors along the way won't be serious.
- The DP community understands what is required of data bases by the CALS.
- DLA is aware of the many redundant data subsets that had come into existance over the years.
- No loss of data is assured.

In conclusion I would like to express my satisfaction with the creative atmosphere and excellent results generated by the Technical Issues Subgroup.

Dr. Ernest Glauberson
PMS 309-41, 692-4050
October 15, 1984

REPORT NO. 8

CALS DEMONSTRATIONS: PROCESS AND RECOMMENDED AREAS

As a result of changing computer technologies, both hardward and software, data processing, in general, and its influence on logistic activities, it is important that a computer aided logistics support (CALS) pilot (demonstration) program be undertaken immediately to resolve the many technical issues that currently face the Department of Defense (DoD) and will be facing DoD over the next five (5) to ten (10) years as we undertake the modernizing of our forces and the automation of DoD services.

The pilot program will take on the following characteristics:

- -- Paralleling of functions (that is, at least two (2) contractors addressing the same technical issue at the same time. This process will provide DoD with comprehensive responses/viewpoints and varying opinions which will assist reviewers in making the best technical decisions).
- -- Contractors will utilize a sub-component(s) or a weapon system as test vehicles.
- -- From this pilot program will come the technical direction for the future computer aided logistics support for all services.

Primary emphasis will be placed on:

-- Standards
  - GENCODE (SGML/DIF)
  - IGES
  - GKS
  - Others (1388, ISO, etc.)

-- Data Base Management Systems

-- Overall Data and System Management
  - Data Storage and Access Retrieval

-- Network(ing) Systems
  - Defense Data Network (DDN)
  - Local Area Network Systems (LANS)
  - Wide Area Networking

-- Data Security

In addition, the CALS pilot program should:

1. Clearly define and specify the ILS master data base.

2. Recommend candidates for automation and candidates for non-automating.

3. Provide key insight into data transportability and transferability.

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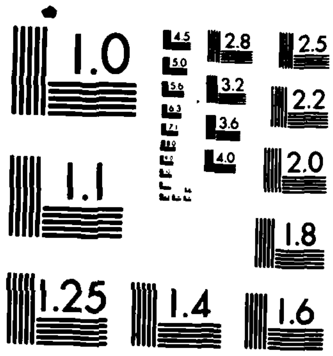
1.0
2.8
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2.2
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4.0
2.0
1.1
1.8
1.25
1.4
1.6

This pilot program should be performed in three (3) phases:

Phase I. Phase I represents a period of gathering and proving of technical facts, at the unit level, the testing of concepts and philosophies, indepth research, formulation of guidelines and standards, and live test demonstrations of accepted and proven advanced technologies; demonstrating applicability to logistics.

Phase II. Phase II represents the subsystem level, where several logistic activities, demonstrated at the unit level, are integrated to perform a large number of logistic operations. Interfaces are clearly designed and tested, compatability issues are resolved, and human factor issues are worked. This phase is an ordered approach to the development of the final system or system level.

Phase III. Phase III represents the system level. This is the phase that requires all the units and subsystems operations to be tested and demonstrated as a total Computer Aided Logistics System.

This approach provides visibility to DoD in ensuring that the CALS system provides and fosters high productivity, innovative and creative approaches as well as solutions with excellent quality products.

Attachments A through E present some of the key technical areas/issues that must be given attention as we proceed with the CALS demonstration(s). †

Attachment F illustrates the three (3) phases required to perform a thorough pilot (demonstration) program. †

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†Attachments A-4 are not supplied with this draft of Volume V.

REPORT NO. 9

THE COMPUTER AIDED LOGISTICS SUPPORT (CALS) STUDY†

PROLOGUE

The following brief description of the manner in which it is presently proposed that IGES and GenCode* be used in tandem to meet, compatibly and concurrently, the needs for Logistics Documentation, Technical Data, and Technical Documentation was first presented to The Technology Issues Subgroup, Mr. Darrell Cox, Rockwell, Chairman, on 9 August 1984, for initial consideration as a potential recommendation to the full body, The Ad Hoc Group on Computer-Aided Logistics Support, being conducted by The Institute for Defense Analyses under the Sponsorship of Mr. Russell Shorey, Director, Weapon Support, Office of the Assistant Secretary of Defense for Manpower, Installations, and Logistics.

The material was subsequently presented to the attendees of TechDoc* VIII, GCA's Annual Conference and Workshop on Integrated Text, Graphics, and Stored Data Publishing, in Denver on 23 August 1984 to provide an awareness of the IDA Study and to invite the comments of those in attendance from the Logistics and Technical Documentation Communities.

It is planned that an expanded, more-detailed version of the approach — reflecting the joint considerations of the National Bureau of Standards, Automated Production Technology Division, Dr. Robert J. Hocken, Chief, for IGES and general standardization issues, and the Graphic Communications Association for GenCode* and other dimensions — will be submitted as the Study progresses.

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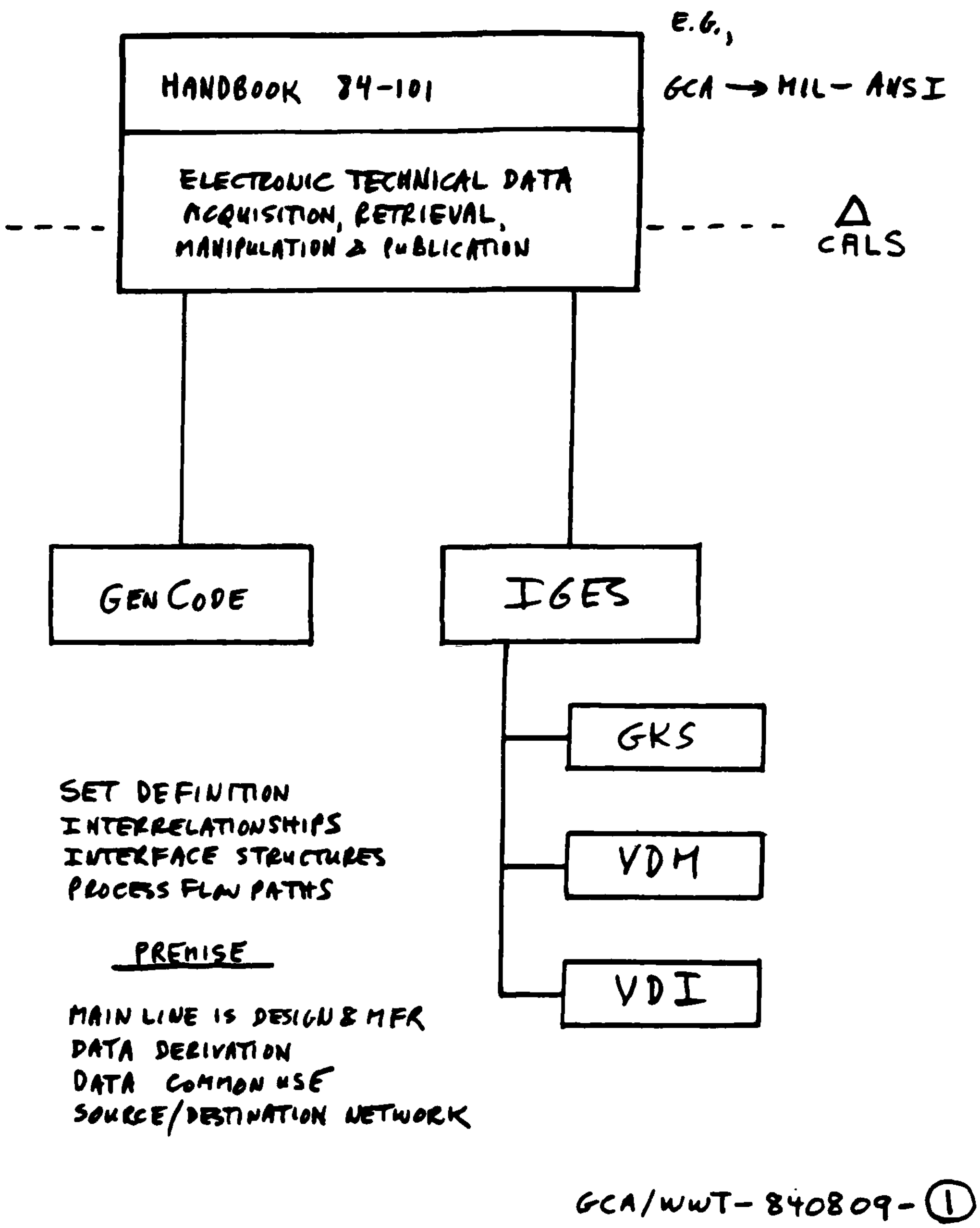
†This document is an edited and amplified version of a paper presented to TechDoc VIII at Denver Colorado on 23 August 1984 by William Tunnicliffe of Graphic Communications Association.

The purpose of this presentation is to acquaint you with a study that is underway under the joint sponsorship of the Office of the Assistant Secretary of Defense for Manpower, Installations, and Logistics and the Under Secretary of Defense for Research and Engineering. CALS stands for Computer-Aided Logistics Support. IDA stands for The Institute for Defense Analyses, which is under contract to perform this study and to come up with some recommendations.

Figure 1 illustrates the fact that the basic thrust of this study, coincidentally enough, has to do with some of the topics that we have been addressing during the course of this meeting. The general objective is to combine the use of data that is prepared and entered for technical-data, technical-documentation, and logistics-documentation purposes. It involves exploitation of both GenCode* for handling text and control and IGES to handle the output and data extracted from the CAD/CAM system chain. IGES considerations, in turn, will lead into considerations of GKS, VDM, and VDI.

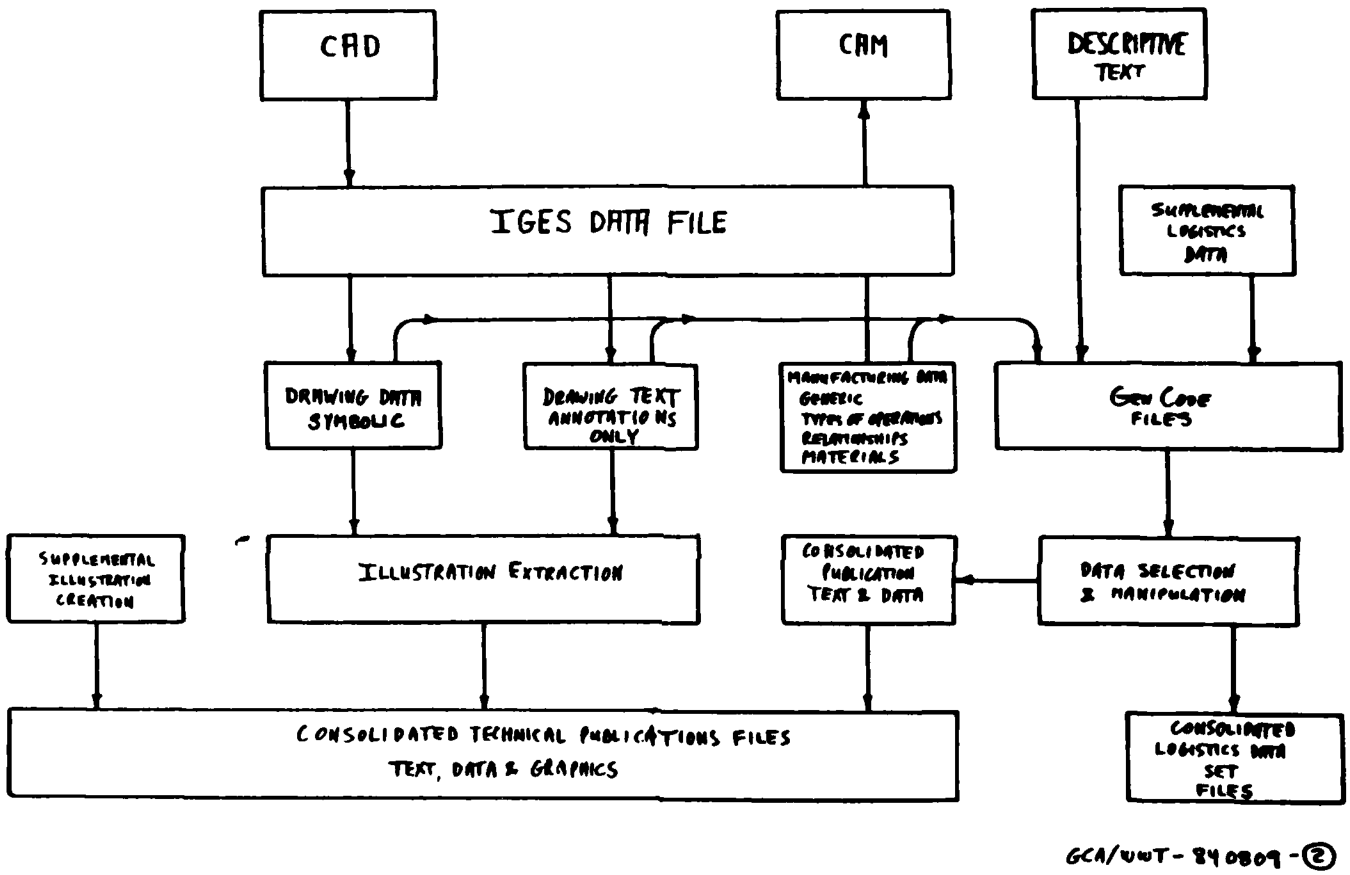
Figure 1 also illustrates the recommendation for a multi-part Handbook consolidating (by direct inclusion and/or by reference and total-unit inclusion) the total set of standards involved, together with procedures and background information describing what the process flow paths are, how the standards interrelate, and what the interface requirements are.

You may look at Figure 2 as a conceptual diagram, and the basic points to which I would like to invite your attention include the fact that the CAD/CAM chain which goes through the IGES data file is what I refer to as the "main line." This main line is the <u>manufacturing</u> path through which you're going to make



E.G.,
GCA → MIL – ANSI
HANDBOOK 84-101
ELECTRONIC TECHNICAL DATA
ACQUISITION, RETRIEVAL,
MANIPULATION & PUBLICATION
Δ
CALS
GEN CODE
IGES
GKS
VDM
VDI
SET DEFINITION
INTERRELATIONSHIPS
INTERFACE STRUCTURES
PROCESS FLOW PATHS
PREMISE
MAIN LINE IS DESIGN & MFR
DATA DERIVATION
DATA COMMON USE
SOURCE/DESTINATION NETWORK
GCA/WWT-840809-1

Figure 1



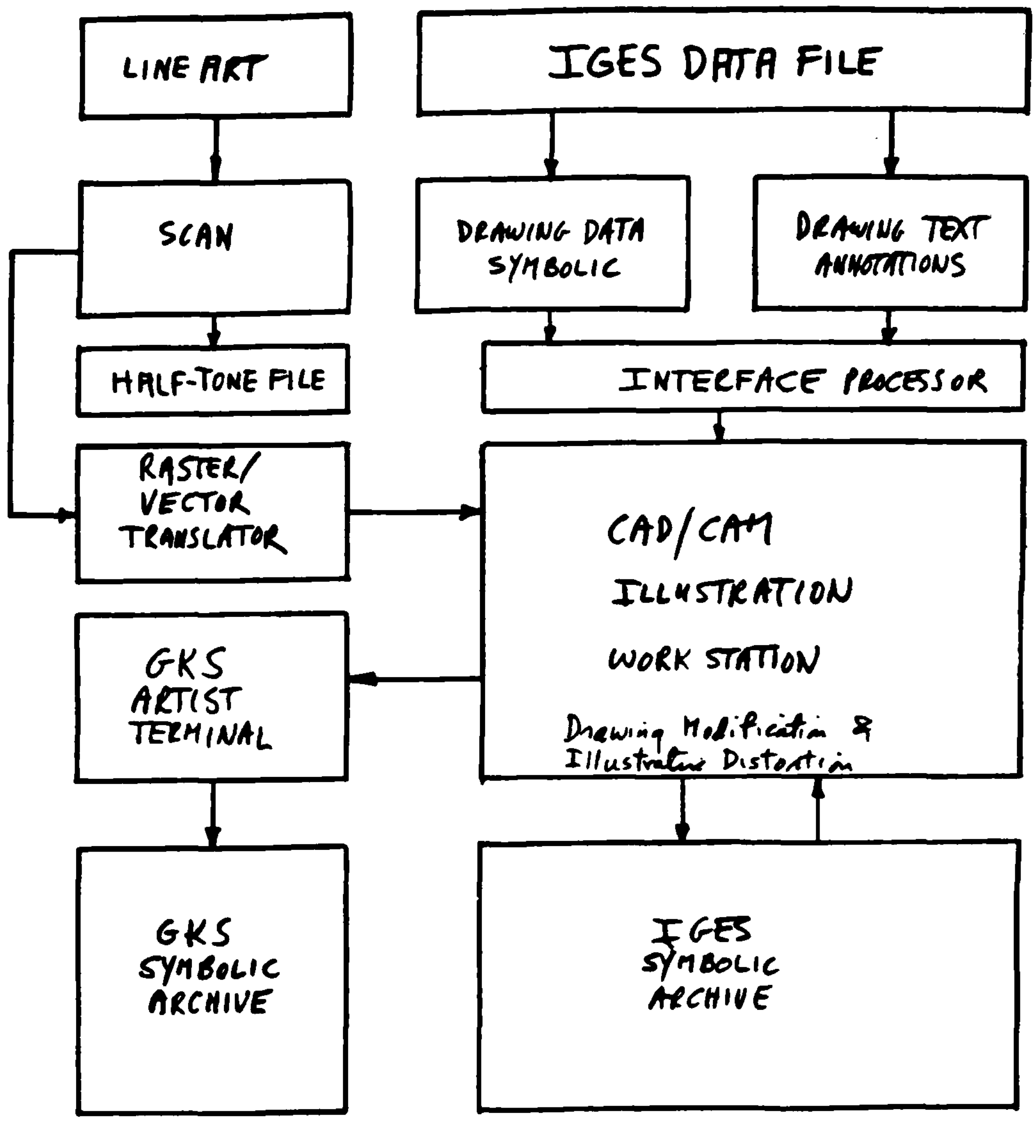
CAD
CAM
DESCRIPTIVE TEXT
IGES DATA FILE
SUPPLEMENTAL LOGISTICS DATA
DRAWING DATA SYMBOLIC
DRAWING TEXT ANNOTATIONS ONLY
MANUFACTURING DATA GENERIC TYPES OF OPERATIONS RELATIONSHIPS MATERIALS
GEN CODE FILES
SUPPLEMENTAL ILLUSTRATION CREATION
ILLUSTRATION EXTRACTION
CONSOLIDATED PUBLICATION TEXT & DATA
DATA SELECTION & MANIPULATION
CONSOLIDATED TECHNICAL PUBLICATIONS FILES TEXT, DATA & GRAPHICS
CONSOLIDATED LOGISTICS DATA SET FILES
GCA/UWT-840809-2

Figure 2

the pieces that make the airplane, and make the pieces that make the electronic subsystem. It is NOT basically intended for TechData or TechPubs purposes per se. Its principal thrust is to enable any conforming supplier to take an IGES data file and to produce that same piece of hardware to use in a system. We are symbolizing the consolidation of all data in this diagram, taking from the IGES data file what can be taken and exploited in the sense of illustrations, taking what can be introduced as text for TechDoc* purposes through a GenCode* or SGML approach, and putting this into one consolidated data file from which you may extract for either purpose — Logistics Documentation, Technical Data, OR Technical Documentation.

The general approach of Figure 2, with respect to the IGES Data File, is to afford separate consideration to the graphic content and to the incorporated data content. Pure drawing content goes through the Illustration Extraction Process exclusively. Drawing identifications — number, title, project nomenclature, etc. — are drawn across to the GenCode* Files for data utilization and associated control information. Similarly, Text Annotations go through the Illustration Extraction Process if needed within the drawing itself. Annotations may go across to the GenCode* File for conversion to typographic-form annotations — as contrasted to its native "CalComp" drawing form — if so desired. The Manufacturing Data would go to the GenCode* File in all cases.

Figure 3 symbolizes the manner in which what I refer to as "illustration extraction" is being investigated. It is assumed that you've heard enough about GenCode* and SGML so that you understand how the text is handled and the purpose here is to outline the



GCA/WWT- 840809-3

Figure 3

avenue of investigation for the art, taking it in symbolic form from the IGES Data File through the interface processor into an Illustration Workstation (to which reference has made in the course of the meeting so far). Within the Illustration Workstation you will modify the drawing to the extent that you can — selecting out the desired portions, discarding the portions not wanted, and giving the proper illustrative emphasis to those portions selected. This will result in the ability to store less data in the IGES Symbolic Archive which, in essence, feeds the consolidated data base. In those instances where you cannot do the job that you want, you then may consider using a GKS-oriented Artist's Terminal to create new illustrations or to perform modifications that are not possible within the IGES system. These new illustrations and/or modifications can then go into a GKS Symbolic Archive — IF you can not get them back into the IGES terminology and store them in the IGES Symbolic Archive.

External art (supplied art or art created outside of the system shown) can be of line form or tonal form. These are fed through the scanner. The halftone file goes directly to the consolidated data base. The line art, after scanning, proceeds through a raster/vector translator to the CAD/CAM Illustrator's Workstation. The line art data then follows the same alternative paths that we have symbolized for basic drawing data coming down out of the IGES Data File.

This is the approach that is being considered. This study is more or less halfway through. The Ad Hoc Group expects to report out by December. It is our intention to present it to you to provide you with an awareness of the fact that the Logistics people and the

Technical Publications people are working together very closely on this and to invite any comments, observations, criticisms, suggestions, modifications that you may wish to present in oral or written form concerning IGES, GKS, SGML, or other dimensions.

Do you have any questions that you would like to pose or any observations?

Question

Do you see one of the results of this system as linking that data into the LSA and LSAR systems?

Answer

The goal of the Logistics people is to come out with a master system that will incorporate all of the elements of LSA. You know from what you've heard here, that, if there is a data element, it can be identified using the techniques of SGML. If you have the data element identifier on it, you have the hooks into which you can connect to move this data out for Technical Documentation purposes or for Logistics purposes. The real thrust of this is the interchangeability of this data between a supplier and the customer — for example, DoD, or to have DoD give this out to somebody else to perform some other task on the data that they may wish to have performed . . . . either internally within DoD activities or externally by a contractor who has been engaged to provide these supplementary services. The real goal is, as you have perceived, not to have parallel systems, but rather to maximize the multiplicity of use of the same data. This, of course, has the obvious benefit that you only change data in one place. You aren't as vulnerable to tracking two or

more systems to keep the numbers the same for the changes you've made.

Question

Concerning availability of slide and oral material.

Answer

We can provide you, from GCA, a certain minimal amount of this material, particularly with regard to those specific areas of the study with which we are concerned. I would, however, make two cautionary observations. It will not be official, and it will not necessarily be the study result which will come along in December. We will be pleased to make study results available when it has been officially issued just as we will be pleased to provide preliminary information at any time in the course of the study.

EPILOGUE: READERS' CAVEAT

The description given above of a proposed recommendation for further study and pilot implementation is a GCA submission. It is not "official." It does not necessarily reflect the views or position of The National Bureau of Standards, The Technology Issues Subgroup, The Ad Hoc Group on Computer-Aided Logistics Support, nor of The Institute for Defense Analyses. It is, rather, in the nature of an "individual contribution" submitted for consideration and possible use.

The Reader is referred to the Final Report, when issued, for accepted, official positions and recommendations.

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*	=	A Trademark of GCA
IGES	=	Initial Graphics Exchange Specification
GKS	=	Graphic Kernel System
VDM	=	Virtual Device Metafile
VDI	=	Virtual Device Interface

REPORT NO. 10

TECHNOLOGY AND STANDARDS ISSUES RELATED TO COMPUTER-AIDED LOGISTICS

Robert J. Hocken, Chief
Automated Production Technology Division
Center for Manufacturing Engineering
National Bureau of Standards

September 12, 1984

1.0 INTRODUCTION

In order that CALS program objectives be met, it is essential that a complete spectrum of standards be adopted or developed. This spectrum of standards must include at least the following:

- Data base standards — this includes standard methodologies for archiving and retrieval of digital data in large volume. In particular, standardization of the software tools to manage and control complex data descriptions is essential. These so-called data dictionary systems must be standardized for a fully successful logistics program in this computer era. (The NBS specifications for a "Core" data dictionary system is an example here.)
- Communications standards — here what is required are the standards that allow implementation of the ISO Open Systems Interconnection Model for network communications, either locally or over extended distances,

between an extremely wide variety of computer systems. (The NBS/GM MAP Protocol is an example here.)

- o Product definition standards — these standards refer to common, computer system independent, methods for providing the complete description of the required product. This description must be sufficiently complete so that the data supplied are sufficient for remanufacture by different facilities over extended periods of time. (IGES and its extensions is an example here.)
- o Graphics standards — a requirement here is for the standards necessary for the archiving of graphic images as well as the standards necessary for allowing graphics manipulation. (Here VDM is an example of a graphics archiving data format, and GKS is an example of a manipulative language standard.)
- o Textual standards — here the requirement is for both a standard means of storing textual data and a standard means for tagging such data with textual constructs. (ASCII code is a reasonable example for the character set storage, while GenCode (SGML) is an example of the language which allows the tagging of textual and other entities for document preparation.)

The above listing represents a minimal set of standards that will be required for a successful implementation of a Defense Department-wide Computer Aided Logistics System. In the following text each of these standards opportunities will be described briefly.

2.0 DATA BASE STANDARDS

An integrated computer-aided logistics support capability will require standardized mechanisms for defining and controlling data. A data dictionary system is a software tool to manage and control complex data descriptions. Data dictionaries allow programmers, analysts, data base administrators, and others to understand and control the data that are in the system. They reduce maintenance costs over the total life of a system, while allowing for planning, designing, documenting, and providing quality control for information resources. The data dictionary is also useful for providing data descriptions to a data base management system or other software system. Thus, a functionaly complete data dictionary system can serve as a logical integrator throughout the total life cycle of an information system. Although data dictionary systems are in their infancy, programs are ongoing around the world to develop standards for the most commonly used (or core) capabilities of a data dictionary system. These efforts are expected to lead to an American National Standard in the 1985 time frame within the United States. It is essential to the CALS program that these efforts be supported and that a standardized detailed design for an external interface to a data dictionary system for CALS be implemented.

Another issue which will be of increasing importance to the CALS program is that of being able to

handle distributed data base systems. Distributed data bases are still extremely poorly understood as few have been attempted in real situations. The architecture of such distributed data bases is also strongly dependent upon the inter-system communication constraints which will be discussed below, under Communications Standards. At this time, distributed data bases or administration systems represent a technical rather than a standards issue, as several years of concentrated research will be required in this critical area before standards priorities can be identified.

3.0 COMMUNICATIONS STANDARDS

Any realistic CALS system will obviously consist of computers and data bases from multiple vendors located at geographically widely varying sites with many locally different needs and/or applications. In order that such a structure be viable, current thought is that a complete hierarchy of network communications standards will have to be developed. Here the worldwide target is the Open Systems Interconnection Model (OSI) where there are extensive ongoing activities, such as the industry government consortium on the so-called MAP program. Since such communication is essential to CALS a significant effort should be made to both understand and support this important standards development.

4.0 PRODUCT DEFINITION STANDARDS

Current product definition standards are confined to standards for data file formats which contain, in principle, all the information necessary for product manufacture. Here the chief standard activity is based around IGES and its successors, which will probably be given new names. As currently constituted, IGES is

relatively complete for the wire frame definition of mechanical parts, i.e., it is capable of archiving and transmitting within multi-vendor systems the equivalent of a mechanical drawing. IGES is, however, like any public domain data format, dependent upon vendor ability to translate from internal representations into this format, thus considerable work needs to be done in order to verify and validate existing IGES translators. Furthermore, for mechanical parts, the expansion of the IGES into true solid modeling is essential. Although the technical work has been done, efforts are needed to convert these early efforts into complete standards. Besides these efforts, IGES must be expanded into other application areas in order to meet CALS objectives. These areas include architectural engineering, plant design, printed circuit board design, cabling and hardness specifications, and integrated circuit definition. Efforts in this area are ongoing but require expediting.

5.0 GRAPHICS STANDARDS

Over the past few years many different proposed or actual graphics standards have emerged. The most important of these for the CALS program are:

- Grahical Kernel System (GKS) — a proposed ANSI Standard addressing 2D graphics functions for computer programmers.
- CORE — a defacto standard addressing 2D and 3D graphics functions for computer programmers.
- Programmers Hierarchical Interface to Graphics (PHIGS) — a proposed ANSI Standard addressing 3D graphics

functions, aimed at applications requiring very high performance and increased user interaction.

- Virtual Device Metafile (VDM) — a proposed ANSI Standard aimed at developing data files for transporting graphics pictures between different devices. It is intimately related to GKS discussed above.

- North American Presentation Level Protocol Standard (NAPLPS) — an ANSI Standard for defining and storing computer graphics information primarily for video text applications. This standard is probably most useful for long-term CALS applications where data are transferred to video terminals in the field.

- Virtual Device Interface (VDI) — a proposed ANSI Standard which defines the interface between independent graphics software and device-dependent drivers.

Each of these standards is intended for a different purpose and is aimed at a distinct constituency. The principle overlap above consists between GKS and CORE, with GKS currently having the broader user base support. Current conception of the CALS program will probably require support in all these areas in order that sufficient options be available to DoD suppliers. Issues include the selection of appropriate standards, testing for conformance to these standards, testing the standards for performance, and standardizing the

interface between graphics and other software tools, such as data base management systems and the textual standards mentioned below.

6.0 TEXTUAL STANDARDS

Standards considerations in the textual area must, by necessity, include both the ability to transmit simple textual data between multiple textual processing systems, as well as incorporating standardized methods for defining textual and graphical elements for the creation of technical publications. The system must be capable of both interfacing with the paper world for a period of many years, as well as providing digital communications where such facilities exist. Thus, it appears to be essential to have a standardized character representation which could be used throughout the CALS program (perhaps such a simplistic representation as DIF for primitive communication between word processors) as well as a higher level textual control standard like SGML (GenCode). GenCode also allows the incorporation of graphical entities into textual structures as is outlined in a separate document by William Tunnicliffe in his report to this Committee.

7.0 RECOMMENDATIONS

Given the above issues and considerations, my current thoughts are that CALS should sponsor the following course of action.

- o Assembling of a team with representatives from the various standards efforts related to CALS to delineate more fully the technical issues, report in detail on current standards contents, provide detailed time

frames, and assess the expansion capabilities within the various areas. Such a team should include representatives from the Department of Defense standards organizations, trade associations, as well as representatives from the principle national standards body, i.e., the National Bureau of Standards.

- Simultaneously with the above, choose several target areas to expedite immediately. Here the idea would be to streamline the existing standardization efforts and to develop verification and validation procedures and methods. Obvious candidates must include IGES for the product data definition file formats, VDM for the graphics data file formats, GKS for graphics manipulation, and SGML for textual definition.

- Initiate development efforts in the areas of standardized data dictionaries and distributed data base systems using the appropriate technical resources, either within the Government or private industry.

- Sponsor and/or facilitate ongoing efforts in network standardization. Of particular concern here is to develop detailed definitions for the areas between the Application level of the Open Systems Interconnection

Model and the lower levels which are being implemented currently.

- o Obtain appropriate expertise for defining the architecture for a complete CALS system in order that this architecture be used for the guidance of future standards and technical development activities.

REPORT NO. 11

IGES, A KEY INTERFACE SPECIFICATION FOR CAD/CAM SYSTEMS INTEGRATION

by

Bradford M. Smith
Joan Wellington
National Bureau of Standards

October, 1984

ABSTRACT

The Initial Graphics Exchange Specification (IGES) program coordinates the efforts of over 60 companies in the development and documentation of a means for graphics data base exchange among present day CAD/CAM systems. The project's brief history has seen the evolution of the Specification from technical development into actual industrial usage. Highlights of the development process have been public demonstrations of vendor capability, the inclusion of mandatory requests for IGES capability in procurement actions, the formalization of the Specification into American National Standard (ANSI) Y14.26M, and the beginning of an effort in the international standards area. To date, seventeen vendor systems have successfully exchanged IGES files in public tests of capability, and over thirty vendors have committed to offer IGES capability. A full range of documentation supports the IGES project, the most recent of which is Version 2.0 of the Specification.

INTRODUCTION

Today all industrialized nations of the world are being challenged to increase productivity in the design and manufacture of products. At the same time, they must face problems of increased product complexity and shortened product life cycles. The development and growth of computer-aided design and manufacturing, commonly known as CAD/CAM, provided a partial solution to these productivity problems.

However, as more and more users turned to CAD/CAM equipment to increase their productivity, they realized that the full potential of this equipment could not be met without a method for communicating data between different systems.

In September 1979 representatives from government and industry joined forces under the Air Force ICAM program to develop this method for data exchange. Funding for management and coordination was provided by the Army, Navy, Air Force, and NASA through the ICAM program. Industrial users and CAD/CAM system suppliers provided resource material and personnel.

Development of the data exchange method was assigned to a technical committee with representatives from the National Bureau of Standards (NBS), the General Electric Company, and the Boeing Company with coordination for the overall effort assigned to NBS. The result of this industry-wide effort was the creation of the Initial Graphics Exchange Specification, known as IGES, which was first published in January 1980 as an NBS report and approved as an ANSI Standard (Y14.26M) in September 1981.

Just what is IGES and how can it increase productivity for your organization? IGES is a data format for describing product design and manufacturing infor-

mation which has been created and stored in a CAD/CAM system in computer-readable form. The IGES format is in the public domain and is designed to be independent of all CAD/CAM systems.

The benefit of this common format is that a user does not have to develop special translators for each different piece of equipment that is used. The only requirement is to have a translator to and from the IGES format. These translators, called pre- and post-processors, are generally available from the equipment vendor. In addition, an IGES file can be stored on magnetic tape or disk memory for future use. It can be transmitted between systems via telecommunications.

Translator Development

The ultimate goal of the IGES project is to allow portability of data among dissimilar CAD/CAM systems. Certainly the development of a national standard is a major step toward that goal. But portability will not be realized until quality translator implementations are in widespread use. Recent events have contributed much toward this goal from both a user and a vendor standpoint.

Many users of CAD/CAM systems have already invested heavily in the development of special purpose software for the design, analysis and testing of their discrete products. As they seek to integrate this software into total design and manufacturing systems, many are making use of IGES to solve their problems of data base communications. The work has a dual focus: transfer of product definition data within the corporate system and digital communication between the company and its suppliers and customers.

From the inception of the IGES project, the graphics vendor community has provided good technical support toward its development. Currently, vendors have either demonstrated their capability or have supplied sample files for testing. Around forty vendors are now committed to supplying IGES translators for their products. The top five CAD/CAM vendors of 1983 (determined by volume of sales) all offered IGES capability. Figure 1 presents this information on vendor implementations.

Intersystem Testing

The first opportunity for exchange of IGES files among different computer systems occurred in the fall of 1981 with the publication of the Test Library. This document and accompanying magnetic tape contain 36 individual test cases of IGES entities.

In December 1981 the first publicly documented intersystem transfer of IGES information in an actual working environment occurred between two operating facilities of the Department of Energy (DoE). A mechanical part was designed and detailed on a Computervision CADDS 4 system located at Sandia National Laboratories in Livermore, California. Three-dimensional model data describing the geometry of this part was expressed in the IGES format on magnetic tape and transported to the Bendix Corporation in Kansas City, MO. There it was interpreted on the Control Data Corporation CD 2000 system where data was added to define a cutter path for subsequent NC machining. A production print from Sandia was used during final inspection to verify part accuracy. The IGES translators used were commercially available, vendor supplied standard pre- and post-processors.

The first public test of IGES data exchange capability took place in June 1982 at the NCGA Exposition in Anaheim, California. The three-dimensional geometry of the mechanical part from DoE was used for the tests. Additional geometry was added to the part with the resulting file being written out on an IGES tape. This tape was carried to the next vendor where it was read in and displayed on the screen. Changes to the model geometry were made at each site and could be seen at all successive locations.

The AUTOFACT 4 conference and exposition held in the fall of 1982 provided the next opportunity for public demonstration. Five graphics vendors participated in that demonstration. Preparations for this test of IGES processors started with part geometry developed by the IGES Test, Evaluate and Support Committee. Figure 2 is a screen copy of the original test part which contained the full range of dimensioning needed for communicating engineering drawings.

A more complex test was performed at the AUTOFACT 5 conference in November 1983. The starting file for this IGES data exchange test contained the three-dimensional wire frame geometry of a complicated mechanical part together with typical dimensioning and annotation on three views. The original geometry was developed by the CAM-I Geometric Modeling Project and was translated into IGES format at McDonnell Automation. Annotation and dimensions were added to the file at Bendix. Hughes Corporation provided final editing to the test file and distributed it to AUTOFACT 5 test participants. Figure 3 shows a dimensioned view of the part. The twelve vendors who participated in that demonstration were Applicon, Auto-trol,

Bausch & Lomb, CALMA, Control Data, Computervision, Gerber, Graftek, Matra Datavision, McAuto Unigraphics, MCS, Inc., and Prime-Medisa. Union Carbide, Oak Ridge, machined the part from an IGES file. That part and a copy of the results of the test were on display at the IGES exhibit.

Plans for the AUTOFACT 6 exposition include an IGES test among 14 vendors. Four new vendors are expected: Hewlett/Packard, InterCAD, SDRC, and CADLINC. Although the geometry of the AUTOFACT 6 test in October 1984 is similar to that used in 1983, the data content is significantly more complex. An improved drawing and view entity structure developed for Version 2.1 of IGES has been incorporated into the test. This cleanly separates the model geometry from display characteristics such scale, view and annotation. Conics in the model geometry are expressed in standard form to alleviate prior instability problems. Dimensions include upper and lower tolerance limits and often make use of multiple font codes. Finally, special feature control symbols are included for squareness, concentricity and parallelism.

The IGES Organization

To accomplish the IGES goal, a committee structure has been established under the leadership of NBS. Overall policy and direction are provided by the Steering Committee which is chaired by the member from the National Bureau of Standards. Other Steering Committee members are management personnel from four different interest sectors: military/government, suppliers of CAD/CAM systems, industrial users of CAD/CAM systems, and members at-large.

Reporting to the Steering Committee are the Extensions and Repairs (E&R) and Test, Evaluate and Support (TE&S) Committees. The majority of the technical work on the project is done by a series of 17 subcommittees under these two committees.

The E&R Committee has primary responsibility for the technical quality of the Specification and as such, deals with all changes and additions. Its subcommittees are active in areas of advanced geometry, finite element modeling, electrical/electronics, plant design, architecture-engineering and construction, manufacturing, and drafting. In addition, the E&R Committee is responsible for the work which produced Version 2.0 of IGES and will produce its enhanced version, 2.1, due to be published in early 1985.

The TE&S Committee has primary responsibility for providing the tools to ensure the development of quality translator software. It provides assistance to implementors including technical review of implementations, resolution of problems encountered, and the general exchange of information in support of the overall implementation of IGES.

One of the first products of this committee was the IGES Test Library mentioned earlier. In addition, it is developing a Recommended Practices Guide to serve as an aid for future implementors by providing descriptions of generally accepted alternatives to common IGES issues. The guide will further serve to establish a general philosophy for IGES implementations. When this committee discovers ambiguous or erroneous areas, it forwards issues which require resolution within the IGES Specification to the E&R Committee.

Meetings as a whole of the E&RD and TE&S Committees are used for dissemination of information and for balloting on the work of their various subcommittees.

Version 2.0

IGES Version 2.0 was published in early 1983 as both a refinement and an extension of earlier published works. Clarity and precision of the Specification were dramatically improved as the result of wider public review and comment plus feedback from an ever-increasing amount of implementation and testing. In addition, many extensions and enhancements were incorporated in the Specification to expand its capability to communicate a wider range of product data developed and used by computer-aided design and manufacturing systems. Despite these extensions and enhancements, Version 2.0 remained nearly upward compatible with Version 1.0. The only exception is a change in the Text Font Definition entity. The Version 2.0 document was approved in July 1982 by the IGES committee structure and published as NBSIR 82-2631(AF) in February, 1983.

Users of Version 2.0 of the IGES Specification will be pleased to see the many technical extensions which have been added to augment its capability and expand it into new areas. Many geometric entities have been enhanced in scope to be more generally applicable. Included here are the parameterization in the Ruled Surface entity, a more general form of the Tabulated Cylinder entity, and the means of relating the Surface of Revolution entity to the common geometrical surfaces like spheres and cones.

Two new geometry entities, a Rational B-Spline Surface entity and a related Rational B-Spline Curve

entity, were added in Version 2.0. The addition of these entities provided a much more general approach for surface and curve representation. New structural entities were also developed and documented for both rectangular and circular arrays of geometric entities.

In the annotation area, Version 2.0 improved on the earlier work by specifying a much larger set of text fonts. Improvements were made in the clarity of intent for positioning and scaling of text material and in a more clearly defined Angular Dimension entity.

Two new applications areas were addressed by Version 2.0: finite element modeling data and electronics printed wiring board product data. The earlier IGES Specification contained no means of handling this data, yet both are widely used applications on CAD/CAM systems.

Version 2.1

Work is nearing completion on a new version of IGES. The document, called IGES Version 2.1, is expected to include additional capability in the geometry area, in references to external IGES files, in expressing the notion of connectivity in a far more capable MACRO feature, and in support of applications areas such as finite element analysis and electronics products. All changes for Version 2.1 have been balloted upon by the IGES committees, and publication is scheduled for early 1985.

International Standardization

The time is appropriate for the consideration of IGES by the International Organization for Standardization (ISO). Active information exchange between the U. S. nd other countries has occurred since

1981. The IGES project has held three major workshops in France and the United Kingdom and maintains active dialogue with groups in France, UK, Canada and Germany. The German DIN organization and the French SET project made presentations to the IGES meeting in February 1984 concerning closer cooperation. The UK has a parallel group aplying IGES to the Plant Design area.

As the first step in the official international standards process, ISO voted in December, 1983, to set-up a technical committee on industrial automation and to create a special subcommittee on the external representation of product definition data. As the first work item for this subcommittee, the U. S. delegation submitted the IGES document.

A first meeting of the subcommittee was held at NBS in July 1984 with delegations from six countries in attendance. Unanimous agreement was obtained on the need for a single international standard for data exchange. Functional capability of the standard was identified, and an aggressive schedule of work was defined.

For More Information

A great variety of formal documentation exists to describe the IGES Specification and its application to CAD/CAM processes. Figure 4 lists this documentation as well as information for ordering the various items.

SUMMARY

Many organizations are anticipating the use of new and improved CAD/CAM systems in an integrated fashion to achieve productivity gains. As you can see, IGES provides a way to achieve that integration. It holds great potential as a common communications format among

automated functions in design, engineering analysis, manufacturing, and part inspection. Additionally, it may serve as a vehicle for meaningful communication of product definition data among different companies over the full lifetime of a product.

In the future, additional CAD/CAM applications will be demanded by users. A standardized communications interface will be essential among the various modules of a CAD/CAM system — essential if these systems are to be flexible enough to adapt to changing priorities and essential if users are to realize the full potential of their equipment. IGES provides that interface.

The present Specification is well developed and tested and is further strengthened by the wide range of supporting technical literature — all of which is in the public domain. Its data exchange technique is well supported by the vendor community. It has been seen approved as an American National Standard and submitted for recognition as an international standard. While the current IGES does not solve all CAD/CAM data exchange problems, it goes a long way toward solving users' current data exchange problems and has the capability of being extended to meet the needs of this growing and maturing field.

PUBLICALLY DEMONSTRATED
IGES VENDOR IMPLEMENTATION
IN
INTERSYSTEM DATA EXCHANGE

- APPLICON
- AUTOTROL
- BAUSCH & LOMB
- CADLINC
- CALMA
- COMPUTERVISION
- CONTROL DATA
- GERBER
- GRAFTEK
- HEWLETT/PACKARD
- IBM CADAM
- InterCAD
- MATRA DATAVISION
- MCAUTO UNIGRAPHICS
- MCSI
- PRIME MEDUSA
- SDRC

Figure 1

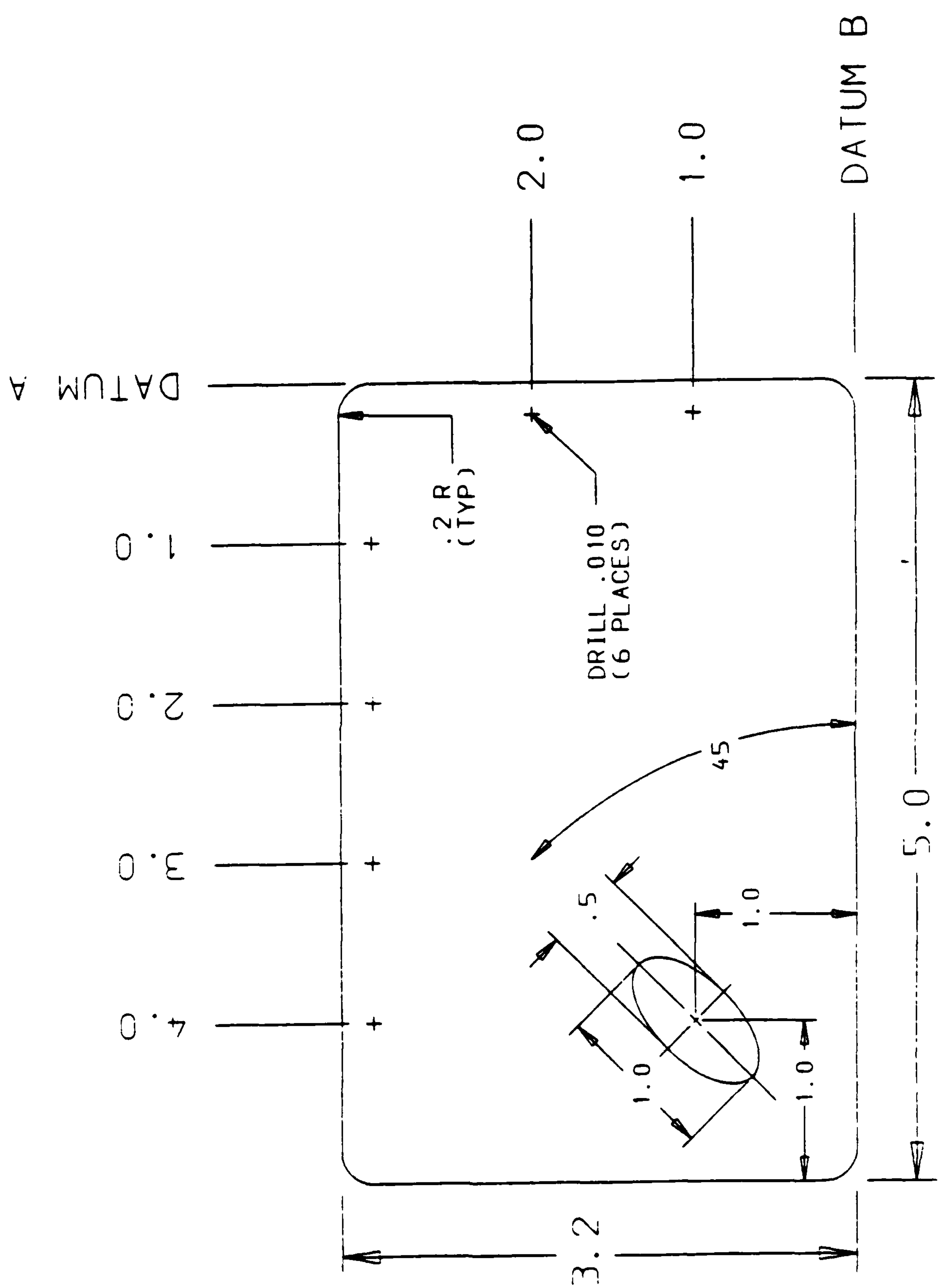

DATUM A
DATUM B
1.0
2.0
3.0
4.0
2.0
1.0
.2 R
(TYP)
DRILL .010
(6 PLACES)
45
.5
1.0
1.0
1.0
5.0
3.2

Figure 2

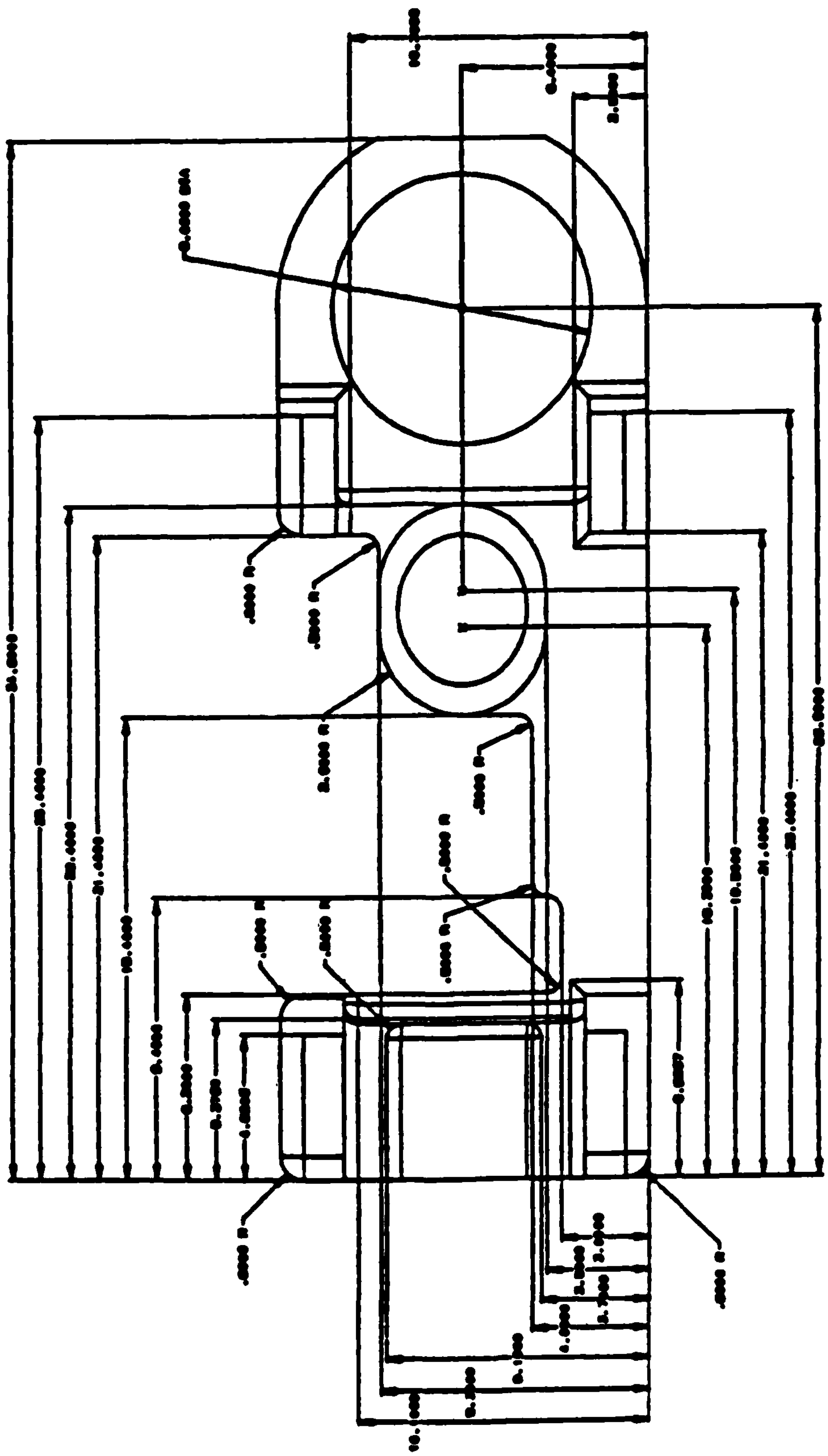


Figure 3

IGES DOCUMENTATION

1. +Technical Briefing (NTIS Order No. PB 81-238719)

2. +Version 2.0 (NTIS Order No. PB 83-137448)

3. oANSI Y14.26M (Order No. N000-99)

4. *IGES Test Library

5. *MACRO Software Manual

6. *IGES Newsletter

7. *Meeting Announcements

AVAILABILITY

*IGES
National Bureau of Standards
Building 220, Room A-353
Washington, D. C. 20234

oASME
United Engineering Center
345 E. 47th Street
New York, NY 10017
Attn: Publication
(212) 705-7703

+National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650

Figure 4

REPORT NO. 12

FOREMAN'S CONCEPT A
LOGISTICS TOOLS: CREATION VS. USE

THREE LEVELS OF LOGISTICIANS

1.	Pre-Conceptual	-	Tool Creation
2.	Conceptual	-	Tool Selection
3.	Practitioner	-	Tool Use

1. PRE-CONCEPTUAL LOGISTICIAN — THE TOOL KIT PROVIDER
   - o Performs real logistics R&D
   - o Determines true cause/effect relationships
   - o Develops logistics tools — dynamic models, etc.
   - o Develops tool application "cookbooks"
   - o Works "outside" the acquisition process, i.e., in generic world, not specific program
   - o Creates logistics technology base.

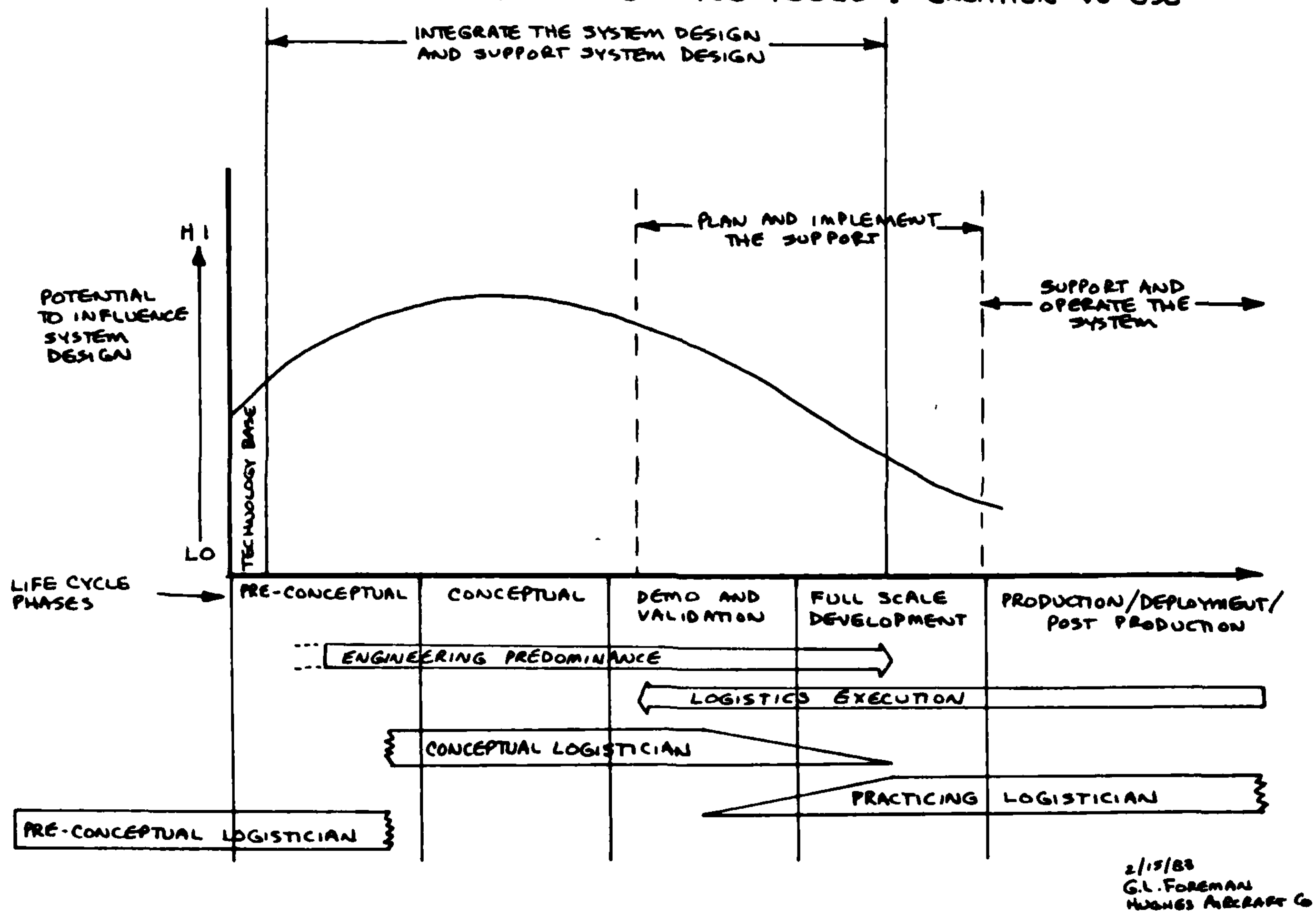
2. CONCEPTUAL LOGISTICIAN — THE LOGISTICS PLANNER
   - o Selects tools applicable to peculiarities of new acquisition
   - o Creatively design support system
   - o Integrates support system design with system design
   - o Provides "roadmap" for logistics program.

3. PRACTICING LOGISTICIAN — THE TOOL USER

- o Applies tools in day-to-day program activity
- o Carries out the logistics program IAW "roadmap" and tool application "cookbooks"
- o Provides experience data feedback for tool refinement/new tool development.

CONCEPT: CANNOT ACCOMPLISH LEVELS 2 and 3 UNLESS LEVEL 1 IS PERFORMED (CREATION BEFORE USE).

FOREMAN'S CONCEPT A - LOGISTICS TOOLS : CREATION VS USE



REPORT NO. 13

ACCESS CONTROL, MANAGEMENT AND INTEGRITY OF INFORMATION

The control and management of access to information and of the integrity of that information is a major issue facing the coming information society. These loom as particularly important issues when considering the many and varied DoD logistics suppliers and the DoD's need for rapid access to logistics support information around the globe.

Access control and management is concerned with the creation, reference, update and deletion of information, and the management of the system which controls who performs these various functions. In the case of DoD logistics information, it is contained in various data bases around the world. A data base is a collection of interrelated files of information together with a description of the set of files, of the links between those files, and of the integrity constraints that apply to these files. Logistics data bases, owned either by the government or by government contractors, often take differing forms. However, accesses to these data bases, in either case, must be limited to those that have need and have been specifically approved by the organization who owns and by the organization that manages the files. It is especially important for contractors to understand this access control and management. They must be in a position to commit proprietary data to these data bases with the assurance that their rights will not be compromised.

Three requirements are readily apparent in considering the control of access to CALS data bases:

a. Personnel with legitimate need for information and authorization to access it should find that access controls do not significantly impede their access;

b. Personnel with no need for the information or with malicious intent with regard to the information should find their access significantly impeded;

c. Integrity of the information in the system should be verifiable at any DoD logistics site. Integrity is defined and discussed in following paragraphs.

In other words, access controls should not impede legitimate users but should impede (and it is hoped, prevent) nonlegitimate users in their attempts to get at controlled information. The *second* requirement above does not, however, deal with the secrutiy requirements on the communications supplied by DCA. Instead, it is intended to address procedures in using the CALS system. Since any system can be compromised with sufficient cost and effort, various access approaches need to be defined based on estimated effort needed to illegally obtain or modify information at the various levels within the CALS system. Again, it is critical for DoD and its many contractors to be satisfied that the CALS access control procedures are adequate for the information that they will protect.

The last requirement addresses the problem of integrity of information in the CALS system. The term integrity is used to mean that information is demonstrably the same after an operation as it was

before that operation (including "storage"). Three factors appear to be important in assuring integrity of CALS information:

a. The time of the most recent modification of the information can be determined and authenticated,

b. The source of the information (i.e., that modification) can be determined and authenticated and,

c. It can be demonstrated that no changes to the information have occurred since the last modification, either accidentally or deliberately.

This may sound like a tall order, and it is. Recently, several techniques have begun to appear that make it a reasonable one. These developments in the field of cryptography address the integrity of information as it is subjected to transfer — that is, communication. The primary body of work has been in the development of the public key concept. This approach to message integrity recently appeared in a proposed standard for message authentification under ANSI committee X9.9. A similar effort has seen its realization in the Guard Device (see Sytek, Inc. report TR82001). This device concept uses a cryptographic checksum approach to control read access to sensitive data bases. In both cases, the concept is to control access by (1) ensuring that the information that is received is the information that was sent and (2) causing unauthorized access to result in at most meaningless data.

The use of a cryptographic checksum combined with the public key cryptosystem concept can be used to

provide a procedure that allows the integrity of messages to be easily authenticated by any person that has the message, the table of public keys, and the two encryption procedures. The required manual procedures for publishing and maintaining the public key tables, the crypto-checksum procedures, and the public key crypto procedure, appear developable into a rational, reasonable, and useful part of CALS.

At this time, neither the procedures nor the supporting hardware necessary to implement access control and management for CALS are inadequate. The last two years of developments in the microcomputer industry have yielded many of the tools that will be necessary to solve these problems. Procedural elements to the resulting access control system must be carefully formulated, particularly in the light of these new developments and the continually evolving base of standards. Development of these procedures is certainly the most difficult task to be addressed in establishing access controls access management and information integrity for DoD logistics support efforts.

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(213) 616-3595
October 1984

REPORT NO. 14

ANSI DATA ELEMENT DICTIONARY

ANSI X12.3-1983 and X12.1-1983 are two recent ANSI documents that should be applicable to CALS. More than applicable, standards in the area of a data element dictionary and purchase order transaction are vital to the CALS project.

Careful review of these two documents has led to the initial conclusion that the concepts and standards described in these documents are cumbersome, awkward and have no reasonable or sound theoretical foundation on which they are based. If the standards were practical and easy to use, the lack of some sound foundation would not be troublesome. However, the complex and laborious standard being proposed has little to recommend it.

A major concept that is missing from the ANSI documents is the generic standard concept that is so well expressed in the DoD GenCode standard. The GenCode has a generic concept allows many different implementation specifications within that concept depending on needs in the various areas of use. It is easy to modify and adapt, yet completely workable. Unfortunately, the proposed ANSI standards are none of these.

Based on the above analysis, it is strongly urged that the technical effort needed to establish an information dictionary and interchange format be considered as the highest R&D effort for CALS. This is an R&D effort since no existing conceptual model is well accepted by either the theoretical or practicing

computer scientists or computer users. The USAF IDEF1 and the more advanced ELKA information model, that was developed at Hughes, provides a sound base for such a standard. However, it needs more work in developing a generic information dictionary standard concept and in defining various implementation specifications. Other sound information models could also provide the bases for a good standard. However, like ELKA, none are instantly ready to be made into a standard.

A CALS concept based on the current ANSI standards will result in DoD and the associated contractors spending billions of dollars more than required and in reduced effectiveness to the entire logistics effort that is too large to contemplate. It therefore, is strongly urge that CALS go forward with the necessary recommendations to develop a new architecture and standard in this vital area.

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October 1984

REPORT NO. 15

NETWORK EXAMPLE
THE SEVEN LAYERS OF THE ISO MODEL

APPLICATION	File Transfer
PRESENTATION	Data Conversion
SESSION	Mailboxes
TRANSPORT	Assembly/Disassembly
NETWORK	Virtual Circuits (Tele. Switch)
DATA LINK	Flow Control
PHYSICAL	Bits & Bytes

ISO OPEN SYSTEMS MODEL

Computations
Accounting
Authoring
Graphics
Design
Control

APLICATION PROCESSES

7 APPLICATION

6 PRESENTATION

5 SESSION

4 TRANSPORT

3 NETWORK

2 DATA "LINK"

1 PHYSICAL

FUNCTIONS

PHYSICAL LAYER (1)

- Physical Connection Activation and Deactivation
- Data Unit Transmission
- Management of Physical Protocols

FUNCTIONS

DATA LINK LAYER (2)

- Downward Multiplexing
- Sequence Control
- Error Detection and Recovery
- Data Link Management

FUNCTIONS

NETWORK LAYER (3)

- Internetwork Connections
- Gateway Management
- Error Notification
- Flow Control

FUNCTIONS

TRANSPORT LAYER (4)

- Message Assembly - Disassembly
- Error Detection and Recovery
- Address Mapping (Transport to Network)
- Multiplexing of Transport to Network Connections
- Sequence Control

FUNCTIONS

SESSION LAYER (5)

- o Setup of Session Protocols
- o Data Unit Sequence Numbering
- o Interaction Management
- o Exception Reporting

FUNCTIONS

PRESENTATION LAYER (6)

- o Session Establishment Request
- o Presentation Image Negotiation
- o Data Transformation and Formatting
- o Special Purpose Transformations (Encryption)
- o Session Termination Requests

FUNCTIONS

APPLICATION LAYER (7)

- Identification of Communicants
- Authority and Authenticity Checks
- Service Quality Negotiations
- Selection of Communications Discipline
- Identification of Syntax Constraints

MARKET OVERVIEW

ISO MODEL	ETHERNET TRACK	IBM TRACK	GM TRACK	AT&T/IS TRACK
APPLICATION	UNDER DEVELOPMENT WITHIN STANDARD BODIES	MICROSOFT MS-NET, XENIX-NET, (FOR NETWORK FILE ACCESS ONLY)	UNDER DEVELOPMENT o ISO FTP o GM MESSAGING	AT&T ISN PROTOCOLS (PROPRIETARY)
PRESENTATION				
SESSION		SYTEK SESSION TRANSPORT, AND NETWORK SOFTWARE		
TRANSPORT	ISO TRANSPORT		ISO TRANSPORT	
NETWORK	ISO INTERNETWORK PROTOCOL (IP)		ISO IP	
DATA LINK	IEEE 802.3 10 MBPS CSMA/CD BASEBAND	SYTEK 2 MBPS CSMA/CD BROADBAND	IEEE 802.4 TOKEN BUS BROADBAND AND BASEBAND	1 MBPS CSMA/CD STAR LAN
PHYSICAL				

OEM COMMUNICATIONS OPERATION

THE EVOLVING FACTORY MODEL: A TIERED NETWORK

FACTORY BACKBONE NETWORK

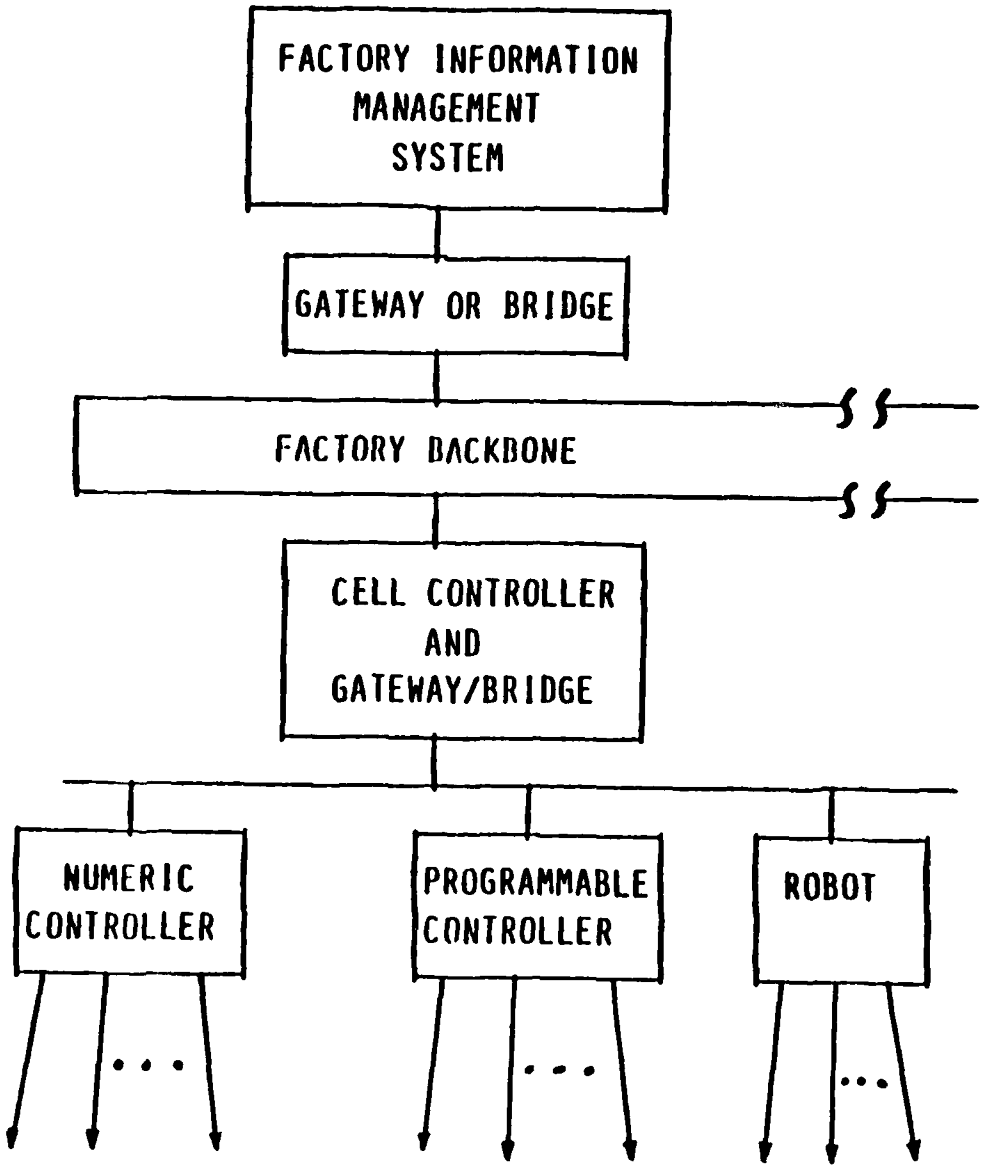
CONNECTING CELLS, FACTORY MANAGEMENT AND CAE/CAD SYSTEMS

INTRA-CELL NETWORK

- CONNECTING NCs, PCs, ROBOTS WITHIN A CELL

STATION TO I/O

- SENSORS ENCODERS
- CONTROL/DISPLAY PANELS
- SWITCHES, STARTERS ETC, ETC, ETC.

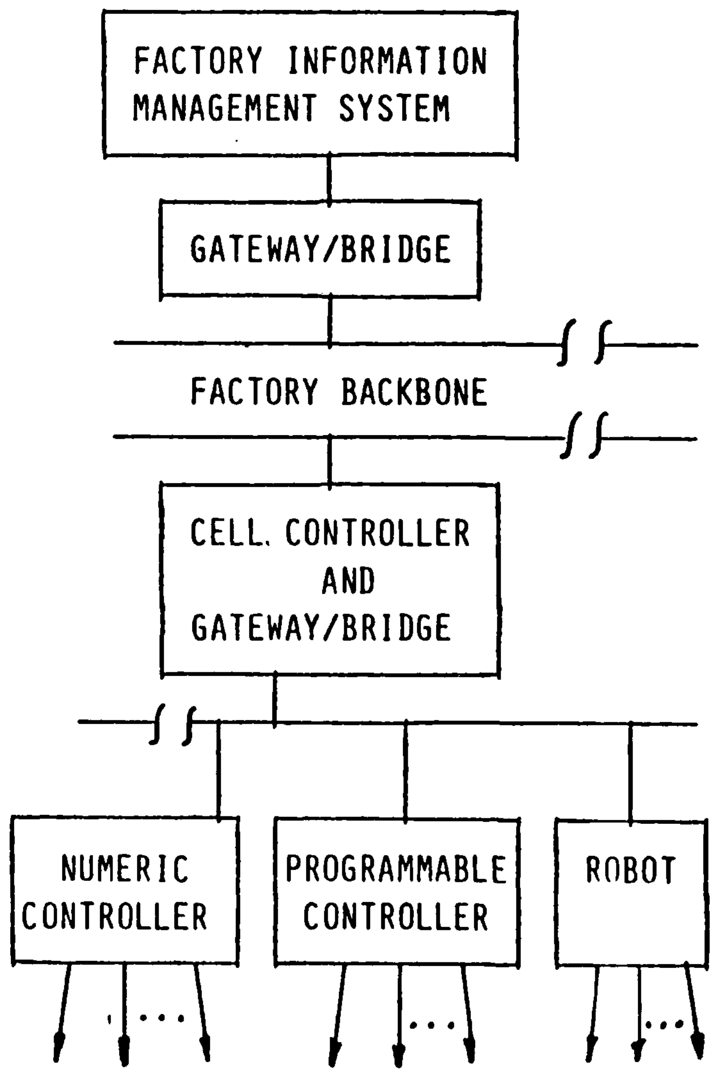


OEM COMMUNICATIONS OPERATION

GENERAL MOTORS MAP:

EMERGING FACTORY STANDARD

FULL OSI 7-LAYER STANDARD
FOR THE FACTORY



FACTORY BACKBONE NETWORK

- LAYERS 1-2: 802.4 TOKEN BUS BROADBAND
- 4: ISO TRANSPORT
- 3, 5-7: UNDER DEFINITION

INTRACELL NETWORK

- OEM SPECIFIC NOW
- MIGRATE TO TOKEN BUS BASEBAND OR PROWAY

STATION TO I/O

- OEM SPECIFIC, NO STANDARD
- PARALLEL AND SERIAL I/O

OEM COMMUNICATIONS OPERATION

GM MAP SUMMARY

APPLICATION	WILL FOLLOW ISO PROTOCOLS UNDER DEVELOPMENT PLUS PLAN FLOOR UNIQUE SERVICES
PRESENTATION	
SESSION	
TRANSPORT	ISO TRANSPORT
NETWORK	ISO INTERNETWORK PROTOCOL
DATA LINK	5 MBPS (OR 10 MBPS) TOKEN BUS BROADBAND
PHYSICAL	1 MBPS (OR 5 MBPS) TOKEN BUS BASEBAND

GM MAP OVERVIEW

- MANUFACTURING AUTOMATION PROTOCOL (MAP) STARTED BY GENERAL MOTORS AND GAINING ACCEPTANCE BY THE LARGE INDUSTRIAL MANUFACTURERS.

- TARGETED FOR PLANT FLOOR COMMUNICATION BETWEEN AND WITHIN WORK CELLS.

- UTILIZES APPROVED STANDARDS WHERE POSSIBLE.

  - IEEE 802.4 TOKEN BUS BROADBAND/BASEBAND.

  - ISD INTERNETWORK TRANSPORT

OEM COMMUNICATIONS OPERATION

STATUS OF GRAPHICS AND DATA BASE STANDARDS

Standard	ANSI Wkg. Document	DpANSI	ANSI	ISO Work Item	DpISO	DISO	ISO	Draft FIPS	FIPS	Other
GKS		X	1/85			X	11/84	X	6/85	
VDM		X	5/85	X				X	10/85	
PHIGS	X	2/85		X	2/85					
VDI	X									
NAPLPS			X							X[1]
CORE										X[2]
IRDS	X	1/85		X				X	9/85	
NDL		X		X	2/85			X		
RDL	X	1/85		X	2/85			1/85		
DF		X					X	12/84		

[1] Also a Canadian standard

[2] A defacto standard

STATUS OF VENDOR IGES IMPLEMENTATIONS

	Demonstrated Inter System	Advertised Translators	Sofware In-Work	Supplied Tape
APPLICON	X			
AUTOTROL	X			
BAUSCH & LOMB	X			
BRUING CAD			X	
CADLINC			X	
CALCOMP				
CALMA	X			
CAMAX SYSTEMS			X	
COMPUTERVISION	X			
CONTROL DATA	X			
FUJITSU			X	
GERBER	X			
GRAFCON			X	
GRAFTEK	X			
HEWLETT PACKARD			X	
HOLGUIN			X	
IBM CADAM	X			
INFORMATION DISPLAYS				
INTERACTIVE SYSTEM				
InterCAD			X	
INTERGRAPH				X
K & E				

STATUS OF VENDOR IGES IMPLEMENTATIONS

	Demonstrated Inter System	Advertised Translators	Sofware In-Work	Supplied Tape
LUNDY				
MARC SOFTWARE				
MARTIN MARIETTA		X		X
MATRA DATAVISION				X
MCS Inc.	X			
MDSI		X		
METAGRAPHICS				
OMNICAD				
PRIME MEDUSA	X			
PRIME PDGS			X	
SDRC			X	
SUMMAGRAPHICS				
SYSTEMHOUSE				
T & W SYSTEMS			X	
TEKTRONICS				
UNIGRAPHICS	X			
VERSATEC			X	
WEBER NC			X	

Bradford Smith

IDA.2-1A

REPORT NO. 16

GENCODE*/SGML STRENGTHS IN THE TEXT PROCESSING ENVIRONMENT

William W. Tunnicliffe
Vice-President, Information Technologies
Graphic Communications Association

1984 December 14

REPORT NO. 16

GENCODE*/SGML STRENGTHS IN THE TEXT PROCESSING ENVIRONMENT †

Table of Contents

† Note (*) is used as a trademark in this report.

SPECIFIC RECOMMENDATIONS

1. It is specifically recommended that the plan and proposal outlined in the PRIORITY ITEM listing and in the following CALS Project Recommendations be implemented as expeditiously as possible.

2. The benefits of the plan include:

   a. Convincing demonstration that will establish credibility for use in the Logistics Area.

   b. Demonstration materials for each stage of the process ---- which may be supplied in "Demonstration Kit" form for widespread, parallel use ---- which will be of significant service in "selling" this application approach within and outside the Department of Defense.

   c. Conclusive evidence of the utility of a combined IGES / GENCODE approach.

3. The tasks included above will show the results of Document Analysis and Document Assembly utilizing the highest attained level of implementation as measured against the latest GenCode*/SGML Standard (Working Draft 9), GCA Standard 101-1983, Change No. 1. It is recommended additionally, that a new, special task be established to provide a retrospective analysis of a project such as ATOS in order:

   a. To utilize the attained results as a platform and vehicle to accelerate the implementation of additional GenCode* Projects; and

   b. To analyze and measure the attained results against the latest version of the standard ---- with a view toward definition of a practical, workable implementation approach which can be used in a significant number of projects in parallel within all applicable jurisdictions.

1.

SPECIFIC RECOMMENDATIONS (Contd)

4. It is specifically recommended that the Program Management approach described be used. This approach will take advantage of the accumulated experience of that group of people who have literally devoted years to the development of the features of the standard and who have very direct experience with system implementations.

   a. The Members of the GCA GenCode* Committe are listed in Report No. 33, "Standards Development Structure and Participating Personnel."

   b. The extent of participation in the ANSI and ISO Standards Development Process is given both collectively and individually.

   c. It is proposed that these individuals provide guidance as a "Board of Overseers" ---- together with individuals from the Project Sponsor organization ---- and provide contribution in the execution of the required tasks.

5. It is felt that the following items, selected from the over-all program/project list which follows, are <u>PRIORITY ITEMS</u>:

   a. <u>Document Analysis</u>

      (1) Thorough, addressing a widely recognized and understood set of documents -- for example:

         (a) A Logistics Document

         (b) The set of Military Specifications and Standards called out for as major project

      (2) Providing an analysis AND an associated tutorial package to <u>explain</u> the approach taken to analysis.

   b. <u>Educational & Training Materials</u>

      (1) GenCode*/SGML Primer

      (2) GenCode*/SGML <u>VIDEO</u> Tutorial

2.

GENERAL RECOMMENDATIONS & OBSERVATIONS

There are several general guidelines suggested for development of an over-all, coordinated program:

1. The concept and status of the standard on the one hand and of implementations on the other simply MUST be understood.

2. It must be understood that, while the standard is well along, implementations must be demonstrated, implementations will be proprietary (in the absence of any other factor), and that implementations are a "must!"

3. The "IMPLEMENTATION" is what allows the "AAP/STM Author Guidelines & Keyboarding Conventions" ---- or the "TechDoc* Author Guidelines & Keyboarding Conventions" to take workable form.

4. The area of focus for GenCode* is "Manuscript Preparation & Text Interchange" ---- with "System and Device Independence" ---- for all areas of Logistics Documentation, Technical Data, and Technical Documentation, leading to the ability to express the material in a variety of output product forms. It is NOT simply to "automate" production.

5. One important exception must be noted for clarity. If one reviews the "whole" standard, one notes that there are 10 parts, of which SGML is Part Six. It must be pointed out that the thrust of the GenCode*/SGML approach is the use of the Text Description Language defined by the the SGML Standard and is restricted to that area. The GenCode*/SGML approach does NOT require, nor does it propose, the use of the Text Processing Language being developed under other parts of the over-all ISO SC18 WG8 / ANSI X3V1.8 standard.

	GENCODE*/SGML	
A. TEXT-PLUS COMPONENTS		
1. Demonstration Projects	Text Only	Text Plus:
a. Document Analysis		
(1) Technical Publication		
(a) Specification	Only	
(b) Standard	Only	
(c) Technical Manual	Only	
(2) Logistics Publication		
(a) LSA / LSAR	Only	
b. Document Assembly		
(1) Technical Publication		
(a) Specification	Only	
(b) Standard	Only	
(c) Technical Manual	Only	
(2) Logistics Publication		
(a) LSA / LSAR	Only	
c. Document Assembly		
(3) Technical Publication		Supplied Art
(4) Technical Publication		IGES
(5) Technical Publication		IGES and GKS
d. Document Registration	By kind of document structure. For all document cases above.	
e. Equipment / System (WYSIWYG on screen;) (SGML codes in output.)	Projected demonstration.	

A. TEXT-PLUS COMPONENTS (Contd)

2. Certification Projects

   a. Retrospective Analysis
   b. Document Assembly Case
   c. List of Certified Implementations
   d. Prior-To-Use Application Plan

3. Project Reports

a.	Progress Reports	Incorporated in Program Management Reports
b.	Project Reports	Final Reports for each Individual Project

4. Training & Training Materials
5. Education & Educational Materials

a.	GENCODE* Primer	
b.	GENCODE* Tutorials	Live, plus handouts
c.	GENCODE* Tutorials	Video Cassette, plus handouts
d.	GENCODE* Tutorials	Audio Cassettes, plus handouts
e.	Handbook	Standards & Procedures Logistics Applications TechPub Applications
f.	Demonstration-Case Exhibit Kits	

B. LIAISON WITH ORGANIZATIONS CONCERNED WITH IGES

1. Automated Production Technology Division
   Center for Manufacturing Engineering
   National Bureau of Standards

C. LIAISON WITH ORGANIZATIONS CONCERNED WITH GENCODE*/SGML

1. WEAPONS SUPPORT / LOGISTICS

2. DMSSO

3. STANDARDS (ASSOCIATION & COMMUNITY)

a.	ISO TC97/SC18/WG8	CLPT COMPUTER LANGUAGES FOR THE PROCESSING OF TEXT; SGML STANDARD GENERALIZED MARKUP LANGUAGE INCLUDED AS SUBGROUP
b.	ISO TC97/SC18/WG1 through /WG5	TEXT & OFFICE SYSTEMS
c.	ANSI X3V1 X3V1.1 thru X3V1.5	TEXT & OFFICE SYSTEMS
d.	ANSI X3V1.8	CLPT TASK GROUP
	X3V1.8.1	TEXT DESCRIPTION LANGUAGE SUBTASK GROUP SGML
	X3V1.8.2	DOCUMENT REGISTRATION PROCEDUR SUBTASK GROUP
	Special Note:	X3J6 was transferred to X3V1 in its entirety and has become Task Group 8 within X3V1.

4. LOGISTICS (ASSOCIATION & COMMUNITY)

5. AIA (ASSOCIATION & COMMUNITY)
   Aerospace Industries
   Assoc'n of America

C. LIAISON WITH ORGANIZATIONS CONCERNED WITH GENCODE*/SGML (Contd)

6. AAP (ASSOCIATION & COMMUNITY)
   Association of
   American Publishers

7. GENCODE* (ASSOCIATION & COMMUNITY)
   Graphic Communications
   Association

8. SGML USERS' GROUP (ASSOCIATION & COMMUNITY)
   Graphic Communications
   Association

D. PROGRAM MANAGEMENT

1. PROGRAM & PROJECT DEFINITION

2. PROJECT/TASK-DIRECTION MANAGEMENT

3. REPORT PRODUCTION -- PROGRESS & FINAL

4. CONTRACTS FROM CONTRACTING ORGANIZATION

5. CONTRACTS TO SUPPLYING INDIVIDUALS & ORGANIZATIONS

6. SCOPE/SCHEDULE/TERMS/COST MONITORING

7. PROGRAM SUPPORT -- ADMINISTRATION, FINANCE, ETC.

E. BASIC PROGRAM PHILOSOPHIES

1. DEPARTMENT OF DEFENSE ADOPTION OF
   GCA STANDARD 101-1983 (10 AUG 1983)
   CHANGE NO. 1 (15 JAN 1985)

2. CONCURRENT PROJECTS & TASKS

3. PROJECTS DIRECTLY FEED

   IMPLEMENTATIONS
   OPERATIONS
   OPERATIONS SUPPORT

4. KEY PERSONNEL AN EXISTING TEAM
   FROM X3V1.8.1
   FROM X3V1.8.2

5. ADDITIONAL PERSONNEL
   BY TASK

PART II. GENCODE*/SGML STRENGTHS

1. Purpose.

Standardization of the computer/system-sensitive text and data format for Computer-Aided Documentation and Publications systems will allow text and data to be exchanged effectively.

The text and data involved covers the entire "need" spectrum: over-all technical documentation (business, logistics, scientific, etc.), specific-system manuals of all kinds (operations, maintenance, theory of operations, training, etc.), drawing nomenclature (title block, bill of materials, and annotations -- i.e., all non-geometric data. The PRINCIPAL STRENGTH of GenCode*/SGML is to address a multiplicity of output, storage, and telecommunications forms from the SAME SOURCE FILE, without having to change the tags.

2. Background

The GenCode* concept and methodology deals with the creation, preparation, processing, and presentation of intellectual content which hasbeencoded (or "tagged") to identify the editorial elements and the editorial structure of the content. In the various processing (or manufacturing) steps in the path from the author's mind to the information consumer's mind (the presentation can be in either printed or electronic form), the editorial tags identify the points in the lineal text stream at which steps in the editorial structure are encountered (see Figure 1) or at which the editorial-element kind changes; at which figures, illustrations, line art, footnotes, or other "detached" materials (i.e., presented "outside" of the lineal text stream) are encountered. (See Figures 2 and 3.) These tag points identify the locations at which the nature of the output presentation device and process must change (i.e., output is machine- or system-particular at output time). Examples include: line-printer, matrix printer, laser printer, facsimile, photocomposition, VDT (video-display terminal),audio, etc. It is important to note that the source file remains the same (i.e., it does NOT have to be recoded) for any variation of visual display output. GenCode*/SGML files are coded in the "language of interchange" -- the neutral format. Each display output device requires its own pre-processor to accept this language of interchange and convert it to the required machine-specific codes for numerical control of that particular output device. (See Figures 4 and 5.)

The basic methodology is one of unique, unambiguous identification of each editorial element. GCA Standard 101-1983, The Document Markup Metalanguage (SGML -- The Standard Generalized Markup Language) provides a syntax and semantics which regiment the coding. This allows operational simplicity and, equally if not more importantly, provides the opportunity for a processing activity (or processing supplier

to create a <u>single</u> SGML pre-processor. The <u>one</u> pre-processor will accommodate <u>all</u> jobs so coded, rather than necessitating a <u>separate</u> pre-processor for <u>each</u> particular job. An important feature of the SGML approach is, for example, the ability to identify a paragraph ---- at <u>any level</u> within the editorial hierarchy ---- by the tag "<P>." The SGML parser "keeps track" of the level of the editorial structure at which that particular paragraph starts and, internally, issues a composite code which identifies the level and the fact that a paragraph is beginning. The "composite" code is called the "Fully Qualified Generic Identifier." (See Figure 6.)

The thrust of this straight-forward example illustrates the power of the GenCode*/SGML approach. The coding is at the highest-possible level of abstraction ---- i.e., the codes (tags) and the content are both within the same character set; there are no "special" codes; there are no "function" codes. Thus, the composite stream is in "neutral" format, a form transparent to the mode of communication. The coding is "human-readable" as well as machine-readable. The whole process is "human-intelligible" ---- almost simplistic. The process constitutes a highly advantageous division of functions: human authors/editors/operators make the intellectual judgments; the SGML pre-processor computer software deals with the complexities and myriads of detail in the full processing.

Figure 7 illustrates yet another dimension of "user friendliness" -- what might be termed "applications-level" standards, or "author guidelines," to establish the editorial identifier tags to suit the preferences (and/or jargon) of any particular user community. Figure 7 shows the AAP/STM (Association of American Publishers / Scientific, Technical, and Medical Publishers) -- the book publishing community -- and Technical Documentation, the Logistics, Technical Data, Technical Manuals, etc. community as two representative cases. Note also that Figure 7 symbolizes the converging technologies and the converging applications of SGML and word processors. Recognition of this convergence has led to the assimilation by ANSI X3V1 of ANSI X3J6 -- to form a combined committee addressing the needs of both Office and Publishing Systems.

Figure 8 symbolizes an important commercial factor. The GenCode*/SGML emphasis is on <u>neutral format</u> to accommodate manuscript preparation and text (all categories ---- facsimile, graphics, audio, etc.) interchange. On either side of the "neutral zone of interchange," there remains unrestricted room to develop and demonstrate inventive expression. The techniques so developed fall clearly within the area of proprietary rights, and, accordingly, provide the desired commercial incentives.

idausn.2-6

3. Implementation

Implementation of a system meeting the requirements of GCA Standard 101-1983, Change No. 1, will require software implementation of a pre-processor. Examples of different approaches to implementation ---- based upon systems approaching compliance with the provisions of the Standards:

(1) The Previous Standard
GCA Standard 101-1983 — Exhibit 1

(2) The Current Standard
GCA Standard 101-1983, Change No. 1 — Exhibit 2

include:

(3) Purchase-of-Services Contract
Computerized Electronic Photocomposition and related services
Internal Revenue Service — Exhibit 3

(4) System Implementation Contract
ATOS - Automated Technical Order System
U.S. Air Force — Exhibit 4

Related background includes:

(5) System Implementation Support Documentation
Document Type Definitions & Examples
ATOS, U.S. Air Force — Exhibit 5

(6) Basic Generic Coding Concepts — Exhibit 6

LIST OF EXHIBITS

4. Definitions. For the specific purpose of the CALS Study, it is important to note that the coverage of GenCode*/SGML includes all of the NON-geometric data and provides the "identification-point" tags which allow proper interlacing of non-geometric and geometric data. Included are:

a. Product Definition Data. Data required to describe and communicate the characteristics of physical objects as manufactured products.

b. Technical Data. The total compilation of all engineering documentation necessary to describe the non-geometric product definition data of engineering drawings in accordance with DoD-MIL-100C, DoD-D-1000B, and MIL-D-5840. This covers title block, bill of materials, and annotations.

d. Technical Documentation. The total compilation of all technical documentation necessary to support the manufactured products. E.g., this documentation includes: business, logistics, and scientific documentation plus system/equipment-specific manuals of all kinds: operations, maintenance, theory of operations, and training.

5. Availability

Copies of GCA Standard 101-1983, Change No. 1, can be obtained from the Graphic Communications Association, 1730 North Lynn Street, Suite 604, Arlington, VA 22209. The current price is $XX.xx.

PART III. GENCODE*/SGML STANDARD DEVELOPMENT STATUS

1. Derivation

The "Generic Document Representation Specification (SGML)," GCA Standard 101-1983, Change No. 1, to be adopted by the Department of Defense, Defense circa 15 January 1985, was developed by the Graphic Communications Association through the work of its members, and other interested parties, by the consensus method within the duly constituted standards development process defined and maintained by the two cognizant standards organizationsthe American National Standards Institute (ANSI) and the International Organisation for Standardisation (ISO). The basic version was coordinated for adoption by the Department of Defense through the Director, Department of Defense Computer Standards Office, Headquarters, U.S. Air Forc and the Defense Materiel Specifications and Standards Office, Office of The Undersecretary of Defense for Research and Engineering. The GCA request for processing the adoption of Change No. 1 will be submitted in similar fashion.

2. Promulgation

GCA promulgated the basic version, and will promulgate the Change No. 1 version, of the standard to provide the domestic and international documentation, printing, and publishing communities with access to this standard for trial-use during the period of completion of the process of formal review and adoption of it by the International Organisation for Standardisation. Adoption of the basic version of the standard on 10 August 1983 by the Department of Defense has served to make the standard available within DoD, the government at large, and commerce and industry in North America, Europe, and the United Kingdom. Adoption of Change No. 1 is expected to have an even greater beneficial effect.

3. Nomenclature

GCA Standard 101-1983, Change No. 1, is the literal text of the document identified as the:

Ninth Working Draft,
International Standard
ISO TC97/SC18/WG8 N40
1984 Nov 08

where:

Technical Committee	97	=	Information Processing
Sub-Committee	18	=	Text Preparation and Interchange
Working Group	8	=	Processing and Markup Languages

and the document is formally entitled:

"Information Processing Systems ----
Text Preparation and Interchange ----
Processing and Markup Languages ----
Part Six: Generic Document Representation Specification (SGML)"

"SGML" is an acronym referring to "Standard Generalized Markup Language," a subtitle phrase previously related to Part Six. Part Six is commonly referred to as "SGML" or "GenCode*." to as "SGML" or "GenCode," independent of any assigned formal title.

4. Status of Ballots

a. DP (Draft Proposed) Registration

The ballot for registration as a DP (Draft Proposed) was issued by the ISO TC97/SC18 Secretariat in November 84 with a return date of 21 Dec 84. The Working Group 8 standard is a "multi-part" standard; the ballot requires voting by individual part ---- i.e., there is an individual ballot for Part Six: SGML.

b. DPIS (Draft Proposed International Standard)

If approved and assigned a DP Number (Draft Proposed), a three-month ballot will be issued by the ISO TC97/SC18 Secretariat for approval of the substantive content. The return date will be planned to occur before the TC97/SC18 Plenary scheduled for Washington, D.C. during the week of 22 April 1985. This ballot will also require voting by individual part. Upon approval, the then-current draft will be issued as a DPIS (Draft Proposed International Standard).

4. Status of Ballots (Contd)

c. DIS (Draft International Standard)

Upon incorporation of any further refinements, the DPIS will be submitted for approval as a DIS (Draft International Standard).

d. IS (International Standard)

Upon completion of further formal processing the document will become an International Standard.

e. ANSI Standard

At that point, it is planned that the document become an ANSI (American National Standards Institute) Standard by adoption in toto.

It should be noted in passing that it is the declared policy of ANSI Committee X3V1, now responsible for the SGML Standard, that every effort should be made to obtain the ISO version of the SGML Standard first, that an independent ANSI version should be sought only after all efforts to obtain the ISO version have failed.

f. Relationship to Word Processing

The word-processing world is currently represented by activities of the U.S. Navy and ISO TC97/SC18 Working Groups 2, 3, and 4. "Document Interchange Format (Interim)," a Naval Data Automation Technical Standard, *NAVDAC PUB* 17.11 ---- *commonly* referred to as "DIF" ---- "provides interim guidance pending formal actions by the National Bureau of Standards regarding the encoding of information for exchange among text processors." The ISO documents, registered as DP 8613/2, DP 8613/3, and DP 8613/4 (Draft Proposed), are formally entitled, "Information Processing ---- Text Preparation and Interchange ---- Text Structures ---- Part 2: Office Document Architecture; Part 3: Document Profile, and Part 4: Office Document Interchange Formats" ---- commonly referred to as "ODA" and "ODIF."

In cooperatively related work of Working Groups 2,3,4, and 8 in an Ad Hoc Meeting in Toronto 19-21 September, in the formal WG3 meetinc in Ottawa 24-28 September, and in the formal WG8 meeting in Rotterdam 22-26 October, the specification text for ODA and ODIF has been modified to incorporate "SGML modules" ---- i.e., operationally, ODA can be speci: by SGML. Technical agreements were originally drafted in Toronto by representatives of Working Groups 3 and 8 of ISO TC97/SC18 and were refir to the satisfaction of both groups in Rotterdam as of 26 Oct 84.

4. Status of Ballots (Contd)

g. Most-Recent Extension

GCA Standard 101-1983, Change No. 1 (i.e., the Ninth Working Draft resulting from international committee work during the Rotterdam meeting of WG8, 22-26 Oct 84) represents both a refinement and an extension of the basic version, GCA Standard 101-1983. Extensions and enhancemenrs have been incorporated in the Standard to establish a compatible "bridge" to and from the word-processing world. The modificati allow, when desired, increased direct relationships between form and content, between word processing and coding according to data element and editorial structure categories.

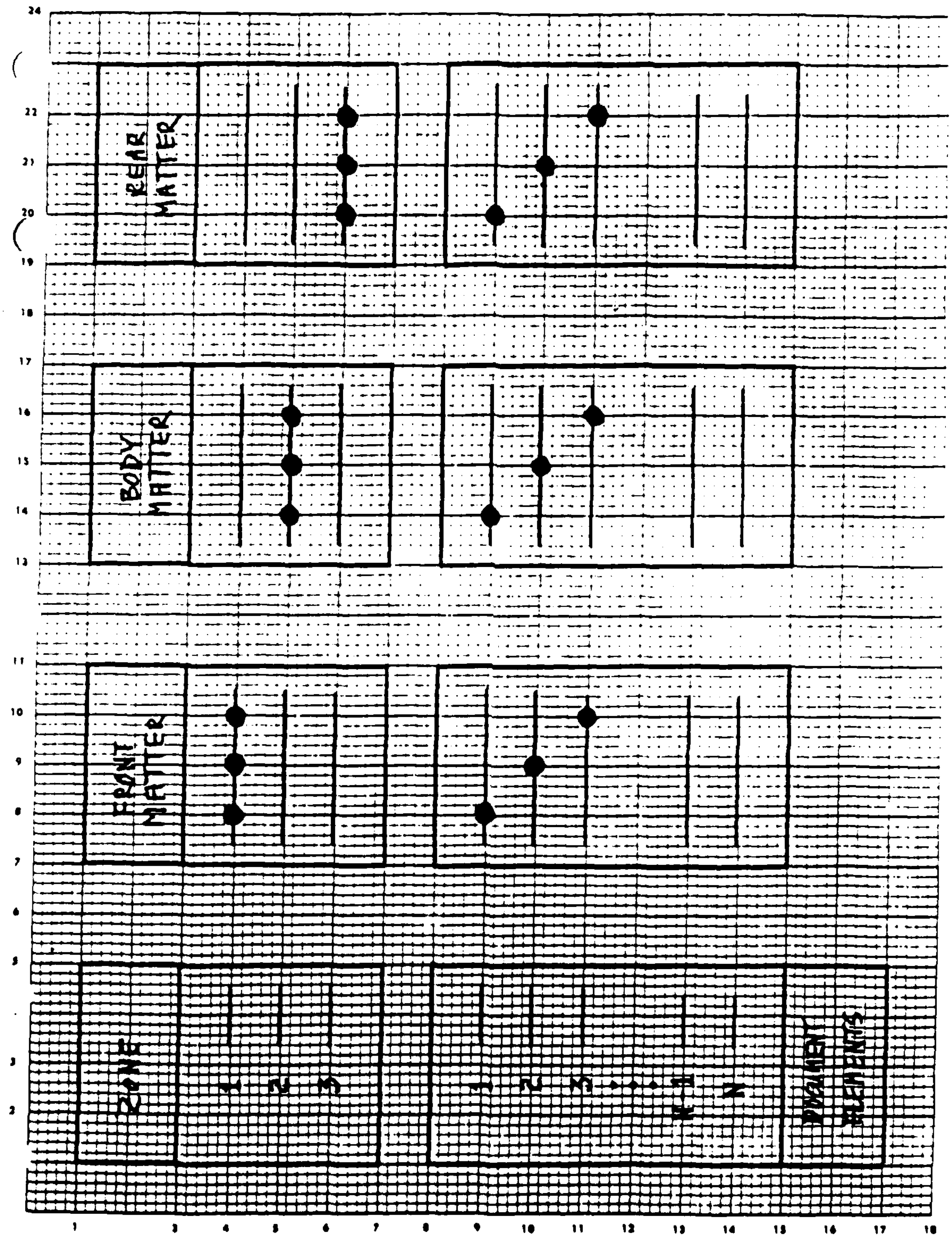


Figure 1

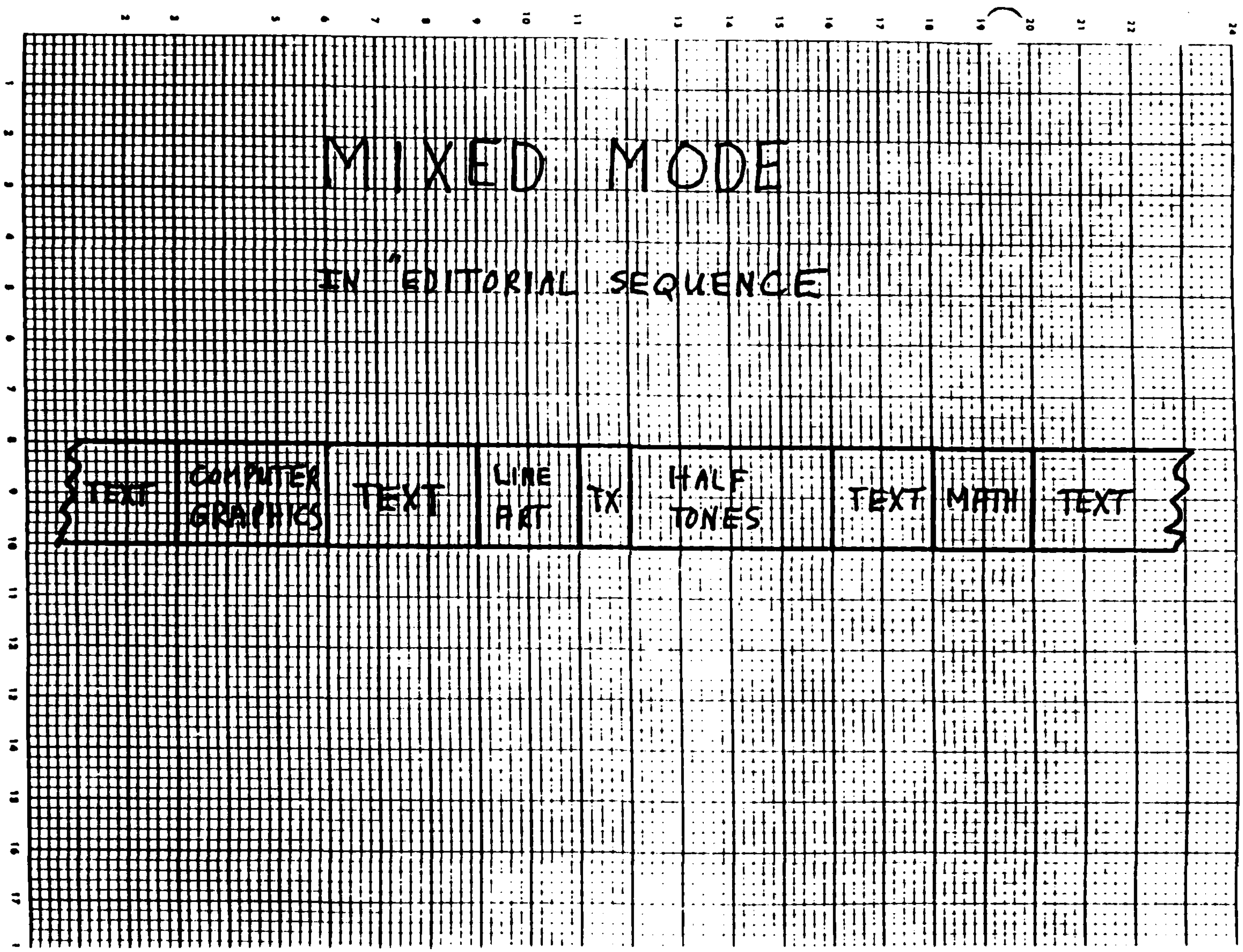

MIXED MODE
IN "EDITORIAL SEQUENCE
TEXT
COMPUTER GRAPHICS
TEXT
LINE ART
TX
HALF TONES
TEXT
MATH
TEXT

Figure 2

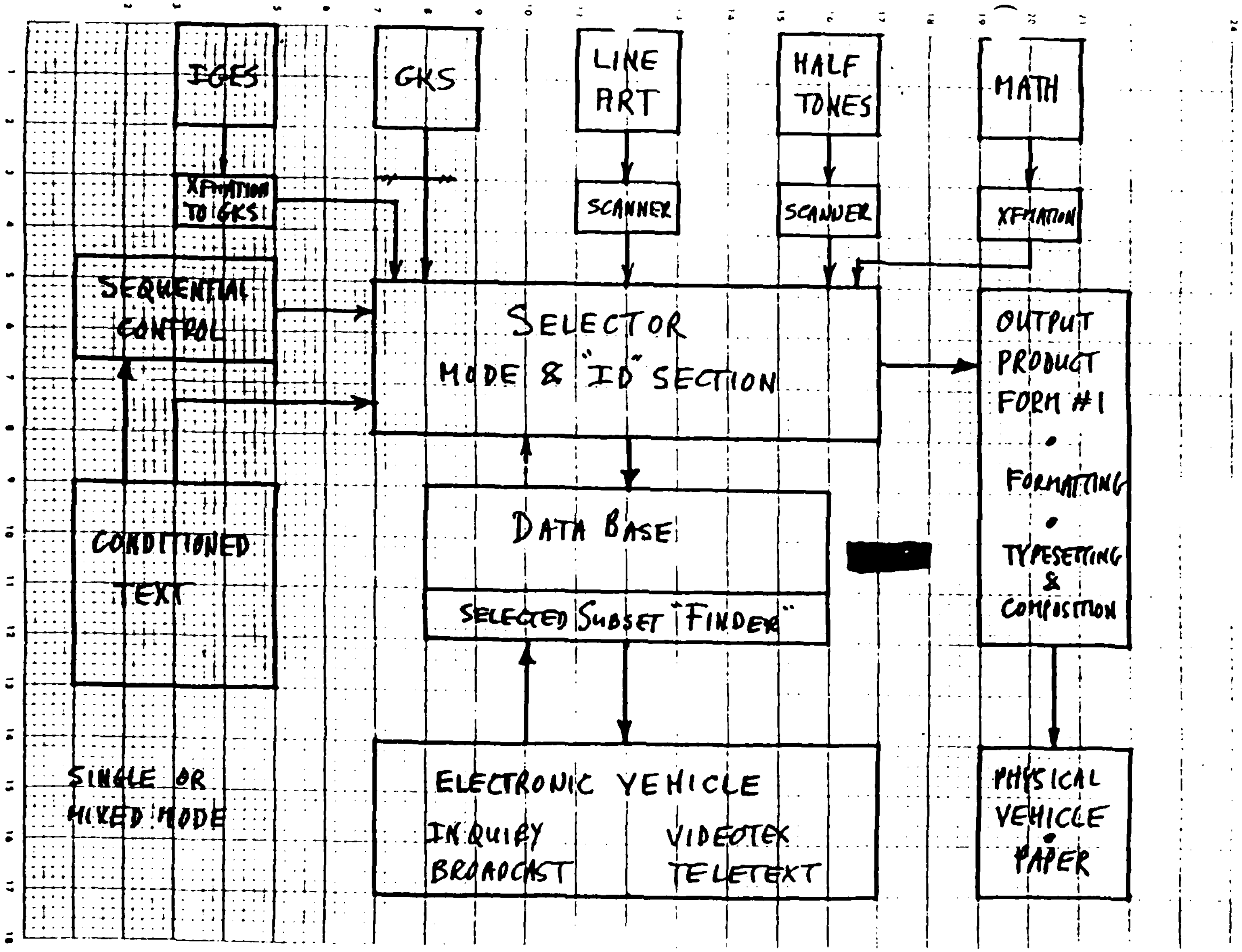

IGES
GKS
LINE ART
HALF TONES
MATH
XFMATION TO GKS
SCANNER
SCANNER
XFMATION
SEQUENTIAL CONTROL
SELECTOR
MODE & "ID" SECTION
OUTPUT PRODUCT FORM #1
• FORMATTING
• TYPESETTING & COMPOSITION
CONDITIONED TEXT
DATA BASE
SELECTED SUBSET "FINDER"
SINGLE OR MIXED MODE
ELECTRONIC VEHICLE
INQUIRY
BROADCAST
VIDEOTEX
TELETEXT
PHYSICAL VEHICLE
• PAPER

Figure 3

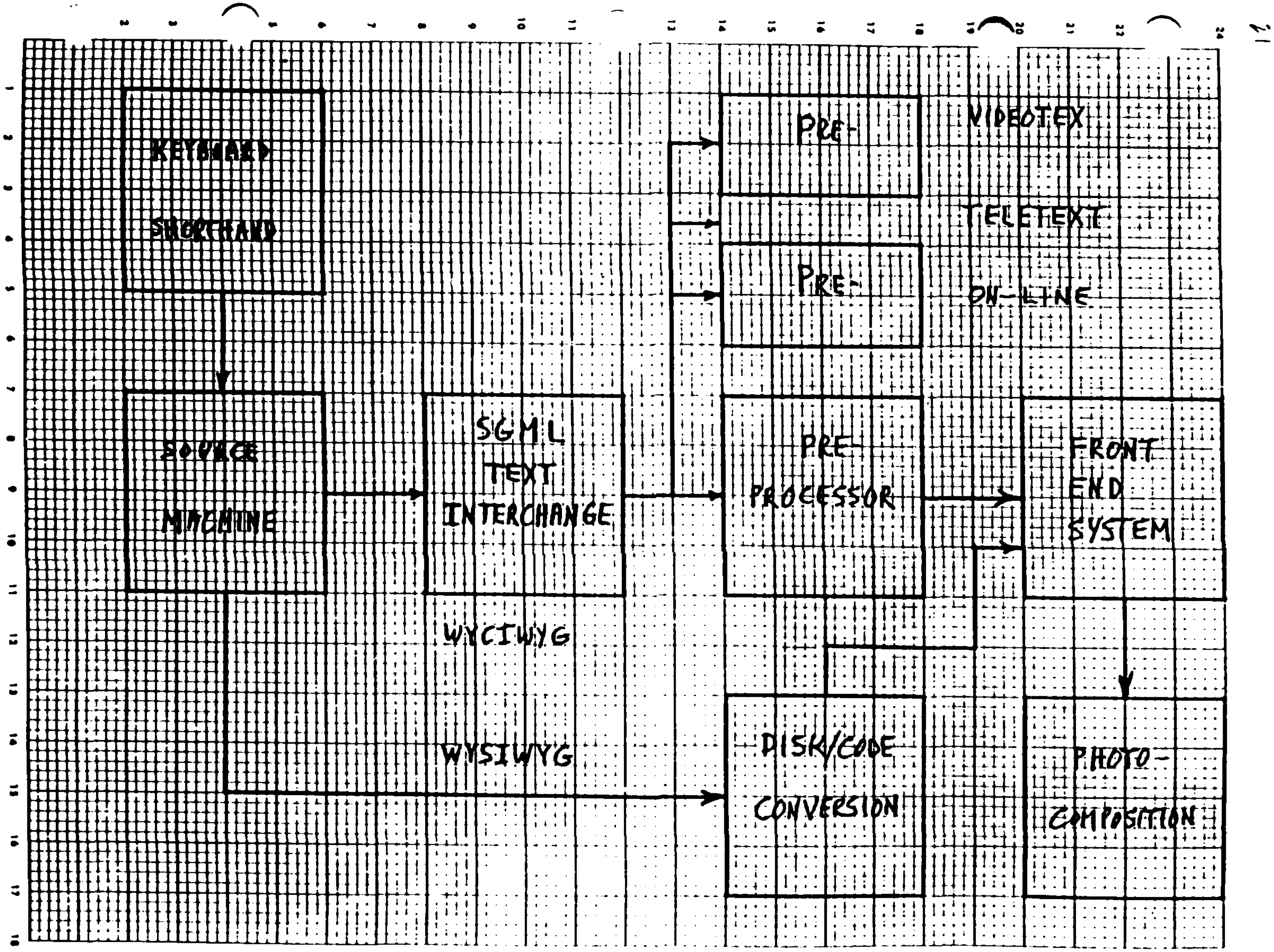

KEYBOARD
SHORTHAND
SOURCE
MACHINE
SGML
TEXT
INTERCHANGE
WYCIWYG
WYSIWYG
PRE-
VIDEOTEX
TELETEXT
PRE-
ON-LINE
PRE-
PROCESSOR
FRONT
END
SYSTEM
DISK/CODE
CONVERSION
PHOTO-
COMPOSITION

Figure 4

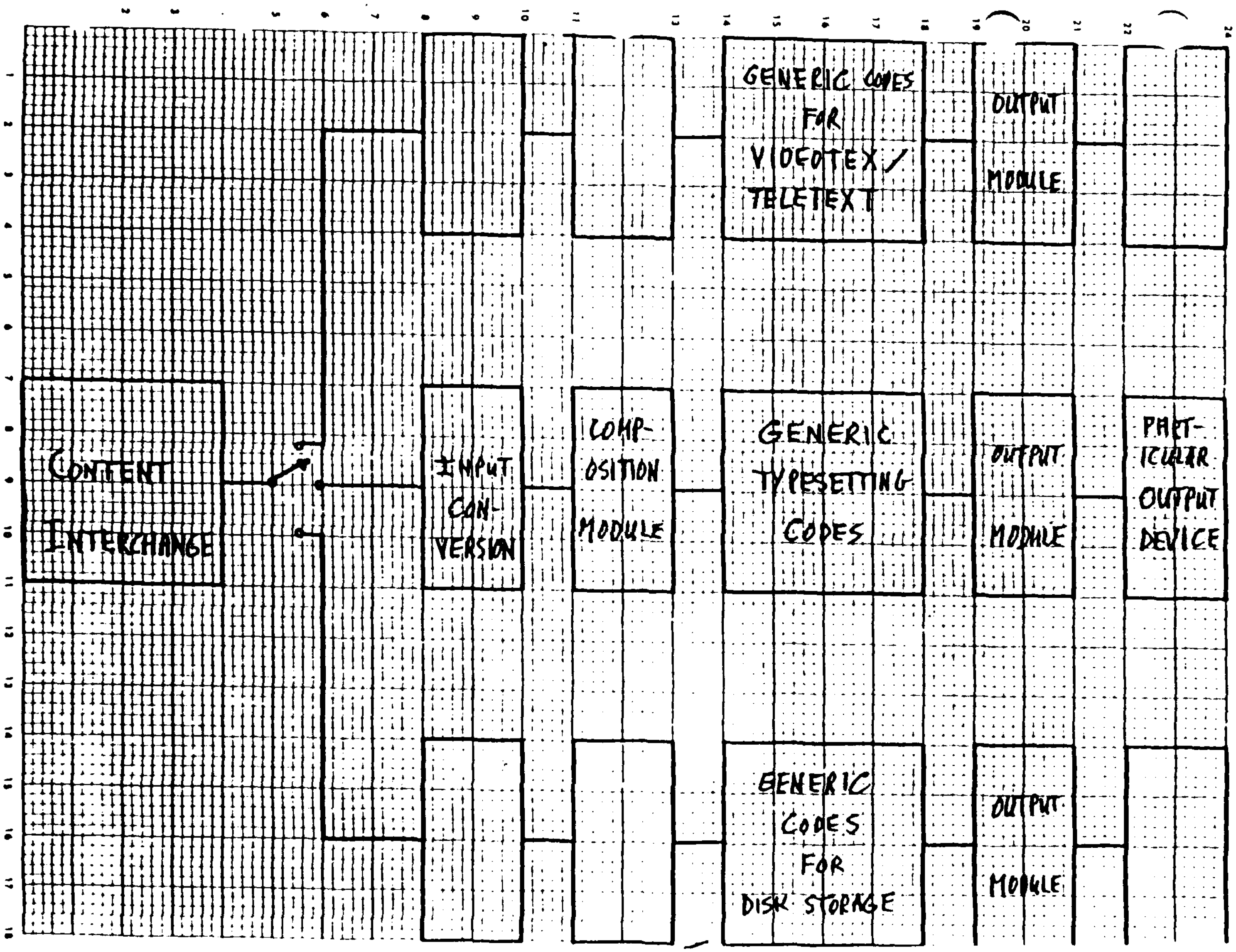
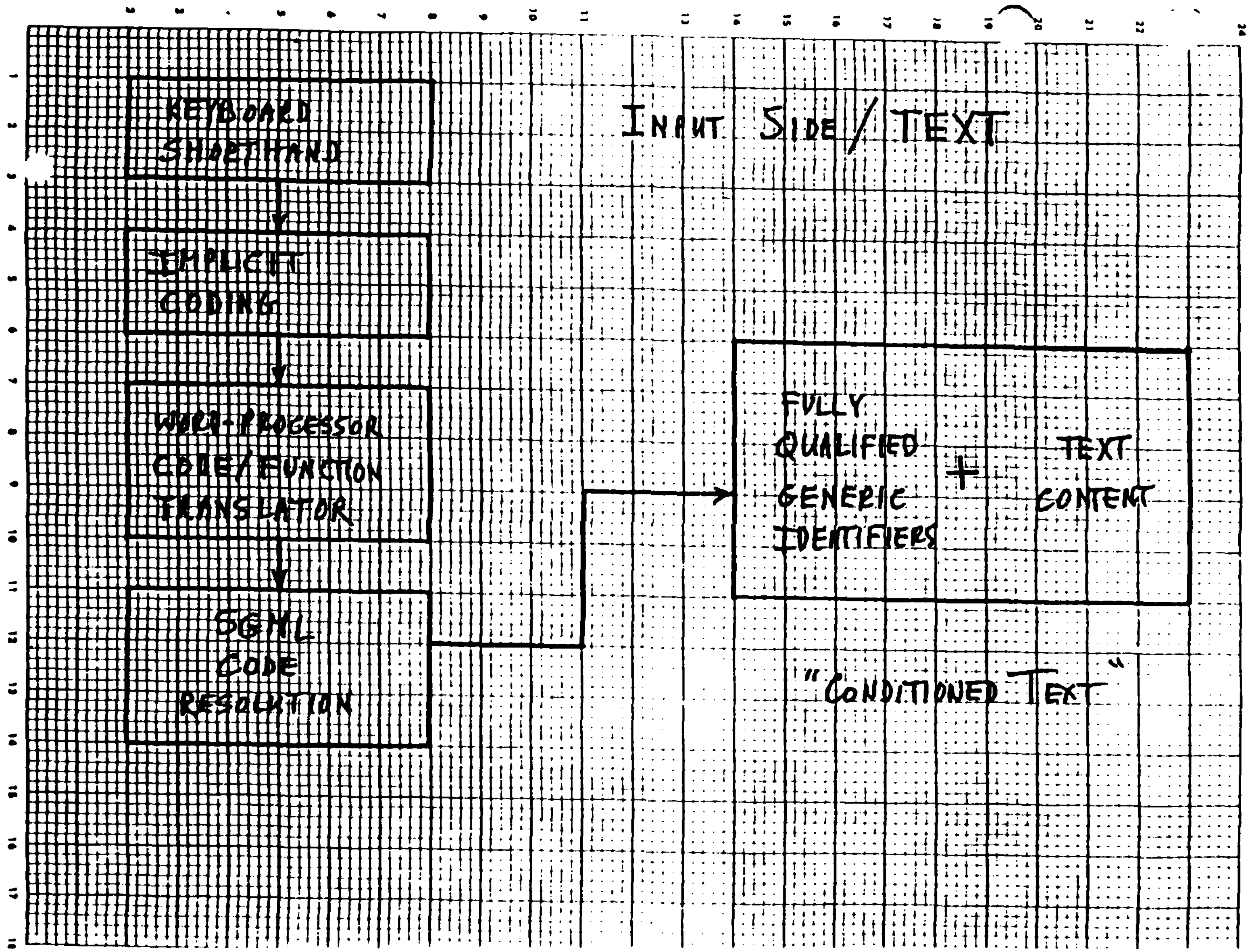

CONTENT INTERCHANGE
INPUT CON-VERSION
COMP-OSITION MODULE
GENERIC CODES FOR VIDEOTEX / TELETEXT
GENERIC TYPESETTING CODES
GENERIC CODES FOR DISK STORAGE
OUTPUT MODULE
OUTPUT MODULE
OUTPUT MODULE
PART-ICULAR OUTPUT DEVICE

Figure 5



INPUT SIDE / TEXT
KEYBOARD SHORTHAND
IMPLICIT CODING
WORD-PROCESSOR CODE/FUNCTION TRANSLATOR
SGML CODE RESOLUTION
FULLY QUALIFIED GENERIC IDENTIFIERS
+
TEXT CONTENT
"CONDITIONED TEXT"

Figure 6

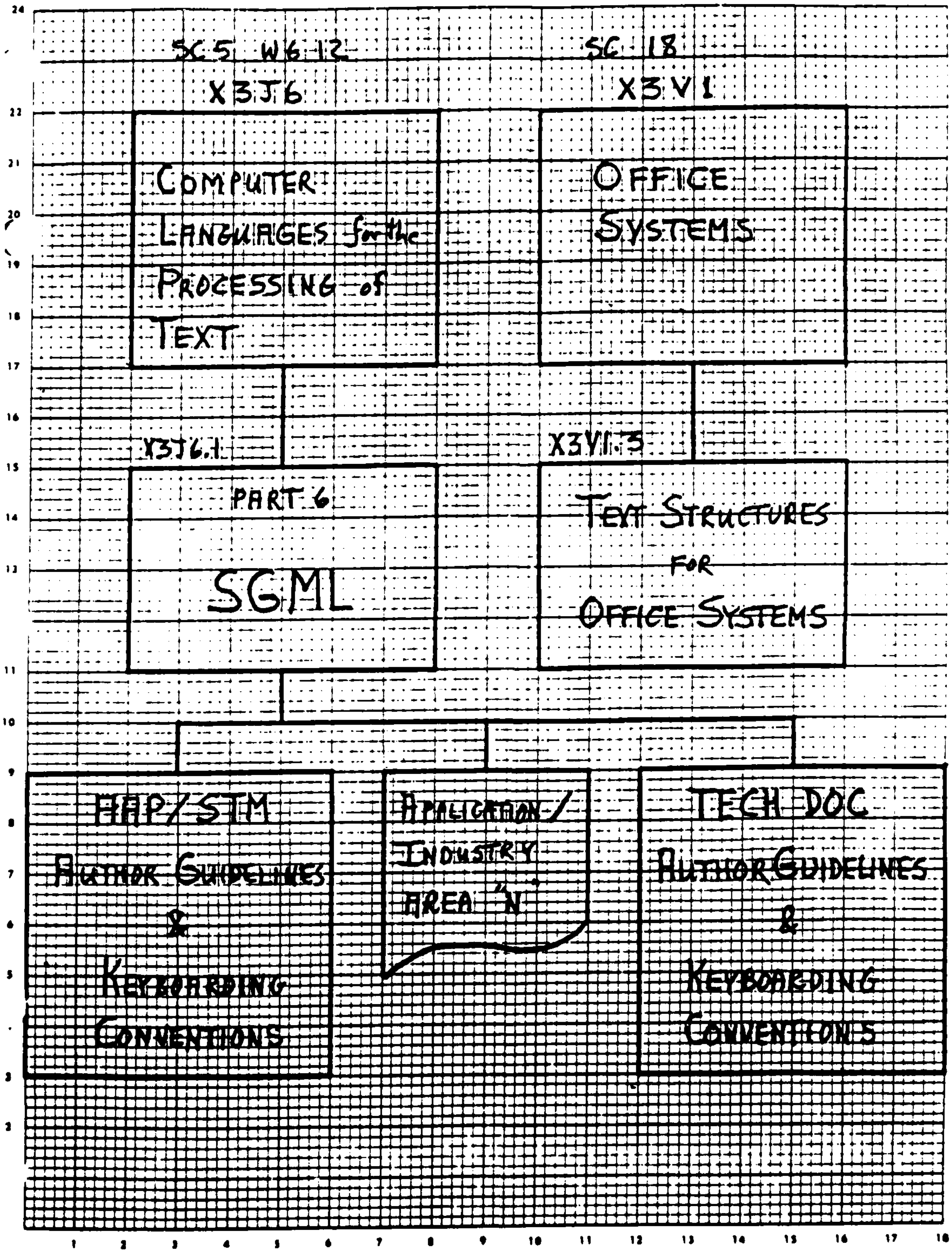

SC5 WG12
X3J6
COMPUTER LANGUAGES for the PROCESSING of TEXT
SC 18
X3V1
OFFICE SYSTEMS
X3J6.1
PART 6
SGML
X3V1.3
TEXT STRUCTURES FOR OFFICE SYSTEMS
AAP/STM
AUTHOR GUIDELINES & KEYBOARDING CONVENTIONS
APPLICATION/ INDUSTRY AREA "N"
TECH DOC
AUTHOR GUIDELINES & KEYBOARDING CONVENTIONS

Figure 7

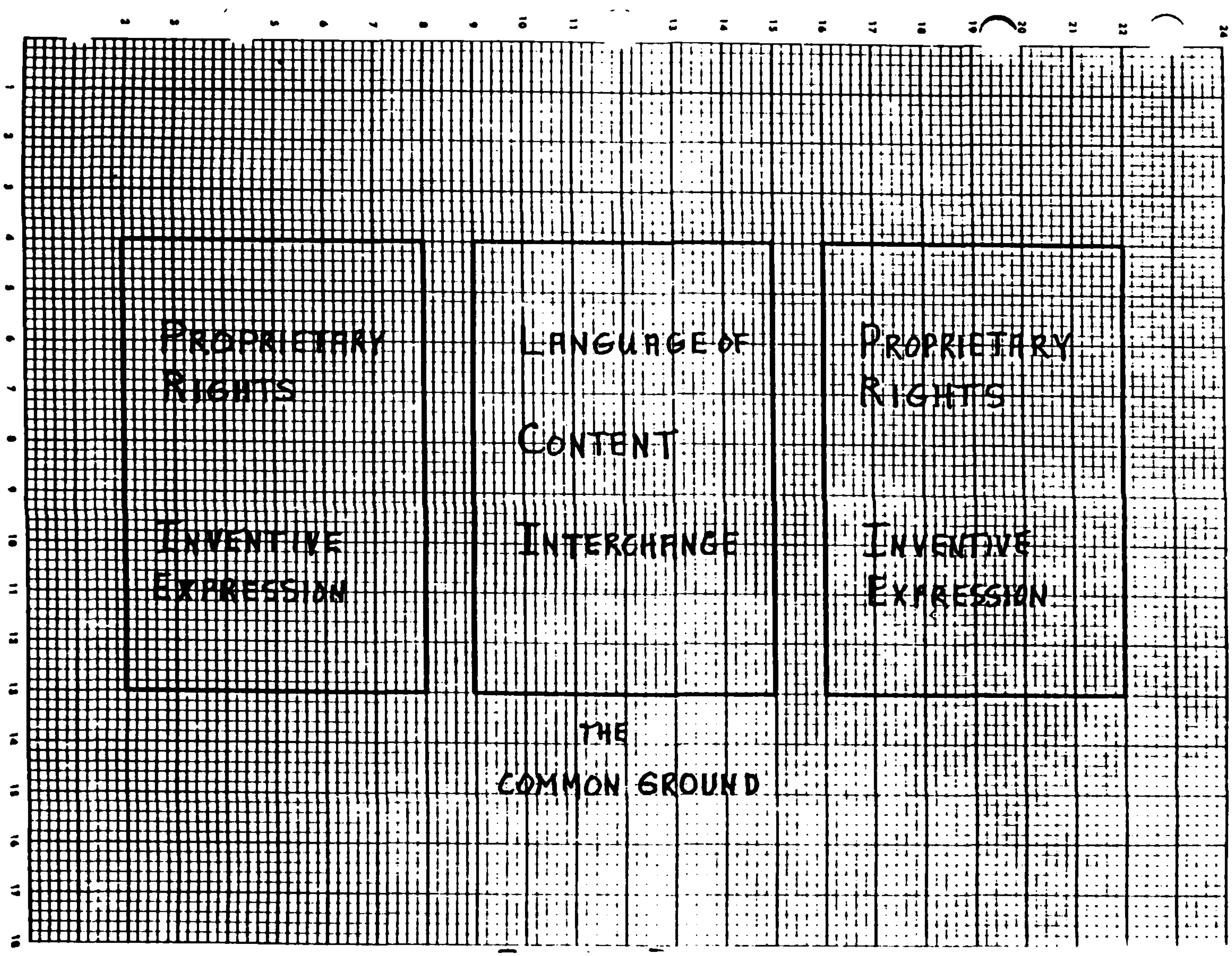

PROPRIETARY RIGHTS
INVENTIVE EXPRESSION
LANGUAGE OF
CONTENT
INTERCHANGE
PROPRIETARY RIGHTS
INVENTIVE EXPRESSION
THE
COMMON GROUND

Figure 8

REPORT NO. 17 A&B

STANDARDS DEVELOPMENT ORGANIZATIONS

STRUCTURE & PARTICIPATING PERSONNEL

REPORT 17A INTERNATIONAL & NATIONAL -- ISO & ANSI STANDARDS FOR MANUFACTURING+

Bradford M. Smith, Chief
Manufacturing Systems Section
Automated Production Technology Division
National Bureau of Standards

REPORT 17B INTERNATIONAL & NATIONAL -- ISO & ANSI STANDARDS FOR INFORMATION PROCESSING+

A. Structural Arrangements

B. GCA GenCode* Committee Member Participation in ISO & ANSI Standards Development Activities

C. Full-Membership Directories

William W. Tunnicliffe
Vice-President, Information Technologies
Graphic Communications Association

1984 December 14

+Attached are partial reports. For information about complete reports contact Institute for Defense Analyses (IDA), (703) 875-2267.

REPORT NO. 17A

INTERNATIONAL & NATIONAL -- ISO & ANSI STANDARDS FOR MANUFACTURING

Bradford M. Smith, Chief
Manufacturing Systems Section
Automated Production Technology Division
National Bureau of Standards

STANDARDS FOR INDUSTRIAL AUTOMATION

When one thinks of standards for manufacturing, first thoughts turn toward those for weights and measures, for these are certainly the oldest and are probably the most frequently encountered on the shop floor when objectives of part interchangeability or system performance demand tight manufacturing tolerances. This view of industrial automation involves many standards that are mandatory and are controlled by law. Application of those standards often occurs through artifacts or gauges that have a calibration traceable to national standards laboratories. While these standards have application to manufacturing, they are not central to problems of CAD/CAM integration. There are other standards that are applied with the force of law. These, of course, include those dealing with safety and health such as pollution control, flammability, shock and building codes. However, mandatory standards will not be addressed here as they are not unique to the problems of industrial automation. Rather, our attention is drawn to the larger number of voluntary standards developed by concensus agreement to define products, practices, materials and interfaces.

One large class of voluntary standards addresses the physical components which together form the industrial equipment itself. Many standards exist here for the electrical, mechanical, metallurgical, and environmental aspects of equipment. Examples would include screw threads, roller chain, and gear teeth. These standards, like those for length and measure, are peripheral to the problems of interfacing computer-based manufacturing systems.

A wealth of manufacturing process standards exist within many industrial facilities to define drawing specifications, part numbering conventions, group technology codes, purchase orders, and such. While these are useful standards, they are not unique to industrial automation and are equally applicable to conventional manufacturing.

Interfacing equipment on the shop floor is often quite difficult because of the lack of standards for electrical voltage and impedance levels of inputs and outputs used for interlock control or for the mechanical interfaces on machine tools and industrial robots. One example concerns robot and effectors. Mounting surfaces and bolt hold patterns have no standards at present forcing a range of grippers to be procured or fabricated for each robot on the floor. An exception exists, however, in the ANSI Standard for tool holders on NC machining centers.

Much of the new automation equipment being installed owes its success to embedded computer technology used to optimize system performance. Additionally, stand-alone computers are assisting at every level of manufacturing planning and control. It is obvious that a wealth of standards exist concerning computer technology. Some of these are pertinent to the application of computers in industrial automation. The key word here is "application" for there is only a subset of computer standards which are germane to CAD/CAM and factory automation. So as not to cloud the main discussions, peripheral computer standards will not be highlighted.

Computer standards which are thought to be useful for applications in industrial automation include those necessary to meet objectives of portability of software, integration of software modules, exchangeability of manu-

facturing data, and distributed data processing. Software portability is addressed by standards for computer languages and program documentation. Also of interest here are the evolving standards to enable applications programming to be independent of the exact terminal devices being used. Computer standards on data base management systems are a necessary part of an approach to integration of software modules.

Exchangeability of manufacturing data is an important issue and is assisted by a range of standards defining data base exchange formats, computer media and languages for manufacturing process descriptions such as are found with NC machining, robotics and coordinate inspection machines. The last area of computer standards applicable to industrial automation focuses upon distributed processing. With the variety of computer-based equipment - micros to mainframes, standalone, and embedded - intercommunications between devices becomes an important issue. A large number of standards address the telecommunications problem, and much recent work is directed at local area networking.

This rationale concludes that the primary interface standards needed by users involved in the design and implementation of industrial automation systems have to do with the application of computers to the processes of design, engineering, manufacturing, planning, and production, and with the mechanical and electrical interfaces of the industrial equipment on the shop floor. These criteria help to limit the consideration of interface standards to a reasonable number that focus attention to the underlying technical problems that are encountered when building integrated manufacturing systems in a multi-vendor environment.

STANDARDS SUMMARY SHEET

Committee Title:

Industrial Automation Systems

Committee Number:

ISO TC 184

Chairman:

M. Dureau, CIT Alcatel, France

Sponsoring Organization:

International Organization for Standardization (ISO), Geneva

Scope:

Standardization in the field of Industrial Automation systems encompassing the application of multiple technologies, i.e., information systems, machines and equipment, and telecommunications.

Areas of Work:

Numerical control of machines
Industrial Robots
Performance Specifications
Product Data Exchange
Programming Languages

Subcommittees:

SC1 Numerical Control of Machines
SC2 Industrial Robots
SC3 Non Device Specific Application Languages
SC4 External Representation of Product Definition Data
SC5 Requirements for Systems Integration
WG1 Communication and Interconnections

Standards Published: Various publications in APT and Numerical Control

Drafts In Work: Industrial Robots - Definition Classification and Graphic Representation

STANDARDS SUMMARY SHEET

Committee Title:

Initial Graphics Exchange Specification

Committee Number:

None

Chairman:

Bradford Smith   National Bureau of Standards

Sponsoring Organization:

National Bureau of Standards

Scope:

Product data representation in computer readable format for exchange and archiving in the area of computer aided design, engineering, manufacture and inspection.

Areas of Work:

Mechanical Design
Electrical Printed Wiring Design
Manufacturing
Finite Element Mesh Definition

Subcommittees:

Extensions and Repairs
Test, Evaluate and Support

Standards Published:

IGES Version 1.0
ANSI Y14.26M
IGES Version 2.0

Drafts in Work:

IGES Version 2.5
Solids Strawman

STANDARDS SUMMARY SHEET

Committee Title:

Numerical Control Systems and Equipment

Committee Number:

IE-31

Chairman:

Al Bacheler   Westinghouse, Pittsburgh, PA.

Sponsoring Organization:

Electronic Industries Association

Scope: Standardization of interfaces with the electronic controllers for numerical control of industrial machine tools and for industrial robots.

Areas of Work:

Communications Protocols
Operator Interface
Control Data Formats
Machine - Controller Interface
Controller Construction Standards

Subcommittees:

Standards Published:

Drafts in Work:

RS 494 Binary CL Exchange Input Format for NC Machines
RS 484 Interface Characteristics and Line Control Protocol

STANDARDS SUMMARY SHEET

Committee Title:
Robotic Systems

Committee Number:
ASTM F-28

Chairman:
Gary Sitzman, Ford Motor Co., Dearborn

Sponsoring Organization:
American Society for Testing and Materials (ASTM)

Scope:
The development of standard terminology, test methods, practices, classifications, and guides for robotic systems. The committee shall coordinate this work with other ASTM technical committees and organizations having mutual interest.

Areas of Work:
Terminology
Performance Criteria
Application Areas
Robot Safety

Subcommittees:
F28.01 Terminology
F28.02 Performance Criteria
F28.03 System Characterization
F28.04 Liaison

Standards Published:
None

Drafts in Work:
Payload Rating Dynamics Test Method
Static Repeatability Definition
Glossary of Terms

STANDARDS SUMMARY SHEET

Committee Title:

Robotic Terminology

Committee Number:

ASTM F28.1

Chairman:

Kenneth Knott, Pennsylvania State University

Sponsoring Organization:

American Society for Testing and Materials

Scope:

Under Revision

Areas of Work:

Glossary of Robotic Terms

Subcommittees:

None

Standards Published:

None

Drafts in Work:

Glossary

STANDARDS SUMMARY SHEET

Committee Title:

Robot Performance Criteria

Committee Number:

ASTM F28.02

Chairman:

John Reidy, Battelle Columbus Labs

Sponsoring Organization:

American Society for Testing and Materials

Scope:

The development of test methods necessary to evaluate the performance of robotic systems and components.

Areas of Work:

Performance Test criteria
Performance Terminology

Subcommittees:

None

Standards Published:

None

Drafts in Work:

Payload Rating Dynamics Test Method
Static Repeatability Definition

AD-A161 781 REPORT OF THE JOINT INDUSTRY - DOD TASK FORCE ON COMPUTER AIDED LOGISTIC..(U) INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA F R RIDDELL ET AL. JUN 85 3/3

UNCLASSIFIED IDA-R-285-VOL-5 IDA/HQ-84-29450 F/G 15/5 NL

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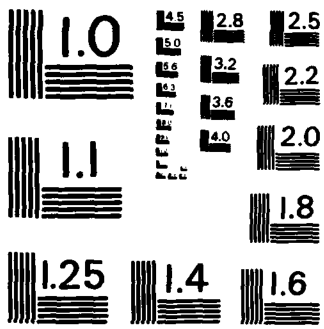

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

STANDARDS SUMMARY SHEET

Committee Title:

Robotic System Categorization

Committee Number:

ASTM F28.03

Chairman:

Brian Ford   Ford Industries, Mahopac, N.Y.

Sponsoring Organization:

American Society for Testing and Materials

Scope:

To define machine characteristics required to form an application system configuration performance.

Areas of Work:

Subcommittees:

None

Standards Published:

None

Drafts in Work:

STANDARDS SUMMARY SHEET

Committee Title:

RIA Standards Committee

Committee Number:

Chairman:

Dr. Samuel Korin IBM Manufacturing Technology Institute

Sponsoring Organization:

Robotics Institute of America

Scope:

Standards and guidelines for construction installation, maintenance, and operation of industrial robots

Areas of Work:

Tooling interface	Safety
Mechanical Systems	Sensory Interface
Construction	Pe.formance
Programming Languages	Terminology

Subcommittees:

Safety

Standards Published:

None

Drafts in Work:

REPORT NO. 17B

INTERNATIONAL & NATIONAL -- ISO & ANSI STANDARDS FOR INFORMATION PROCESSING†

William W. Tunnicliffe
Graphic Communications Association

Table of Contents

† This is a partial report. For more information contact the Institute for Defense Analyses.

REPORT NO. 17B

INTERNATIONAL & NATIONAL -- ISO & ANSI
STANDARDS FOR INFORMATION PROCESSING

Table of Contents - Continued

	In Order Of:	
	ISO	ANSI
Convenor/Chairman	Convenor	Chairman
Vice-Chairman	-	X
Secretary	-	X
International Representative	-	X
Vocabulary Representative	-	X
Voting Members and Alternates	X 35/9	X 18/9
Members in Jeopardy	-	X 0
Conditional Members	-	X 2
Observers	-	X 2
Liaison Representatives	X 9	X 10
Consultants	X 10	X 10
Probable New Attendees at Next Meeting	-	X 4
Total	54/9	46/9

REPORT NO. 17B

INTERNATIONAL & NATIONAL -- ISO & ANSI STANDARDS FOR INFORMATION PROCESSING

Table of Contents - Continued

Note: For information about the complete report contact IDA (703) 845-2267.

REPORT NO. 18
SUPPORTABILITY IMPLEMENTATION
IN THE ACQUISITION PROCESS

Summary

- o The design of weapon systems occurs in a tightly compressed schedule environment in which the supportability influence must be exerted. The use of computers will enhance this process by integrating various design and supportabililty functions.
- o A variety of data bases exists which serve diverse functions. It is necessary to extract specific data elements for use by various disciplines from product concept formulation to customer feed-back.
- o Many models exist today which are used as peripheral tools to assist the designer and supportability engineer. These models impact various phases of the acquisition cycle and it is necessary to ascertain if the algorithms in these models can be integrated into a large scale model with milti-purpose capability.
- o Logistics requirements can be extracted from the CAD/CAE that affect the generation of LSA sheets and cards. Furthermore, the design of support equipment and training devices can naturally follow from the air vehicle (or other system) design information.
- o The design algorithms must be specifically tailored to address the intended use of the system, its operational environment and integration with lessons learned and statistical data feedback.

See the attached visual presentation material for details.

Bob McCall
Lockheed Aircraft Co.

Lockheed-California Company

SUPPORTABILITY (S) RESEARCH HIGHLIGHTS

	MILITARY	COMMERCIAL
Design Control	Military Specifications "Bottom Up" Approach	Specification Language "Top Down" Approach
Maintainability Emphasis	WUC 11 and Up [LRU Analysis]	Flight Line Operations [Minimum Support Equipment and Arrangement and Installation of Equipment]
Design Analysis	Measures of Logistic Effects to Influence Design	To Correct Design Causes of Logistic Effects
Major "Intended Use" Aircraft Characteristic	Utilize Existing Support Equipment [Heavy Dependency on the Main Operating Base]	Maximum Self-Sufficiency and Capability for Maintenance During Turnaround

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Supportability — A New Dimension In Design

DESIGN CAUSE ⟶ LOGISTIC EFFECTS

DESIGN CAUSE

- Supportability (S) Analyses
  - Intended Use
  - Design for S Baseline
  - Aircraft S Characteristics
  - S Design Features
- S Design-To Requirements (SDTRs)
- S Configuration Audits
- S Specification Language
  - Makes S the Designer's Job

LOGISTIC EFFECTS

- Logistic Analyses (FMECA, RCM, RLA, O & S Costs)
- Logistic Requirements
  - Maintenance Tasks
  - Logistic Resources
- Measures of Logistic Effects
  - R & M Parameters
  - Predictions and Allocations
  - Goals and Thresholds

DEMONSTRATION AND VALIDATION PHASE

This LSA flow chart from MIL-STD-1388-1A shows the allocated baseline as an output of the LSA. This baseline is supposedly substantiated by extensive and expensive logistic analysis paper studies required by the LSA process. The results of these studies show up in the contractor's proposal as $\underline{S}$ design features. These features are like asterisk option items on the dealer's brochure when buying the family automobile and generally have to be specified and paid for up front to be included when the vehicle is delivered. Only those $\underline{S}$ features that are included in the air vehicle contract are safe from being traded away in the FSD design process. The allocated baseline and proposal studies are not sufficient to "get ready" for FSD insofar as $\underline{S}$ is concerned.

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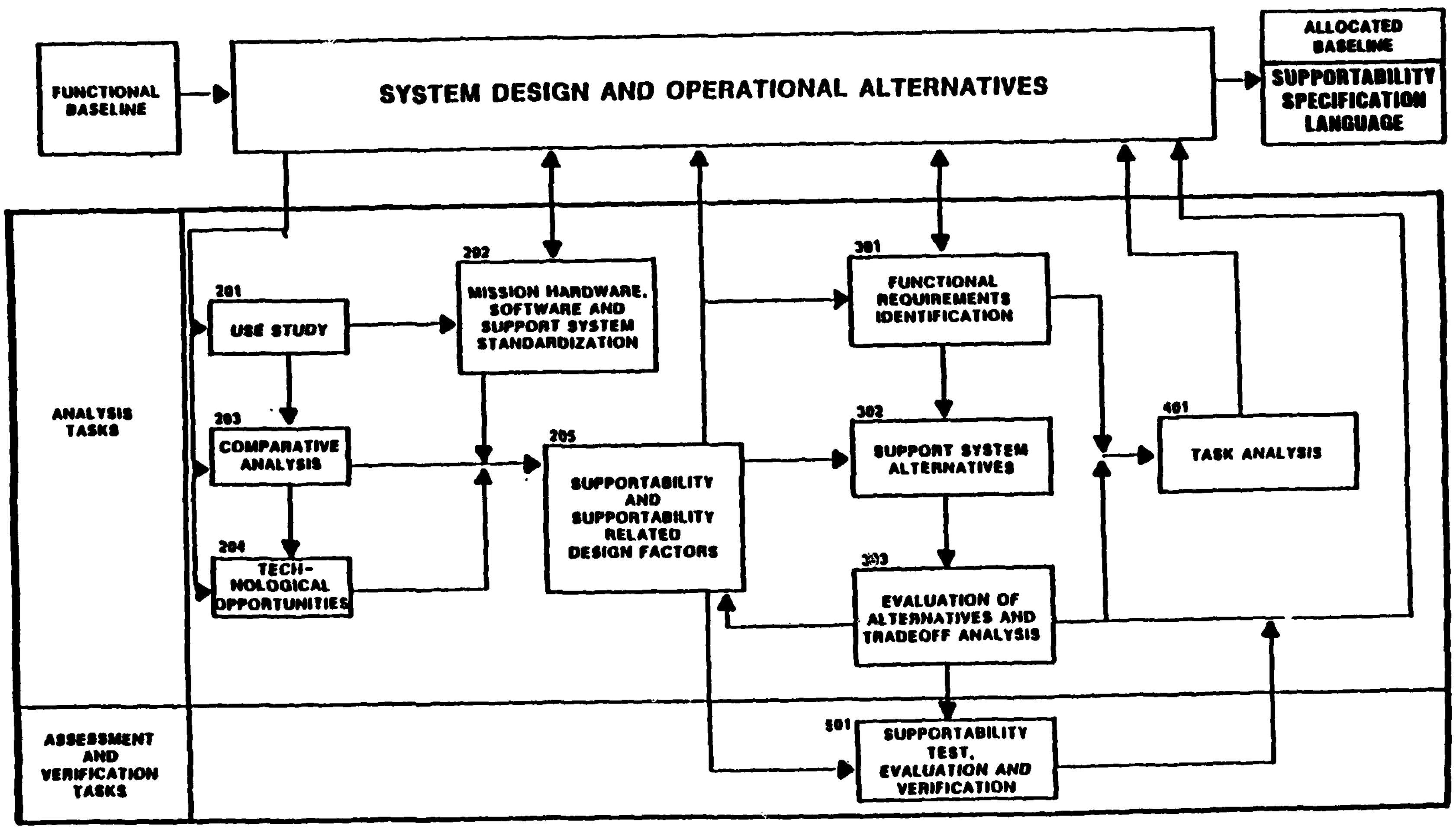
DEMONSTRATION AND VALIDATION PHASE



SUPPORTABILITY FRONT-END ANALYSIS

This is to reemphasize that the Lockheed approach to S front-end analysis establishes what the design "must be". It is also to be noted that all the logistic analysis techniques are not only in place but are reinforced.' For instance, Reliability and Maintainability parameters can be stated as SDTRs and backed up by specified design features that will provide a basis for the R & M parameters and allocations to be contractual.

The remaining charts and discussion pertain to application to new unclassified vehicle study programs. It is emphasized that all charts and discussion pertain to generic air vehicles. No reference is made to specific configuration of any vehicle, only S research conclusions are intended.

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Supportability Front-End Analysis

DESIGN CAUSE ⟶ LOGISTIC EFFECTS

SUPPORTABILITY (S) ANALYSES

- Establish What The Design "Must be"
- Analysis Approach
  - ► Intended Use
  - ► Design for S Baseline
  - ► Aircraft S Characteristics
  - ► S Design Features
- S Design-To Requirements (SDTRs)
- S Configuration Audits
- S Specification Language
  - ► Makes S the Designer's Job

LOGISTIC ANALYSES

- Determine Logistic Impact Of A Design "In Being"
- *Existing Methodologies* (FMECA, RCM, RLA, O&S Costs)
- Logistic Requirements
  - ► Maintenance Tasks
  - ► Logistic Resources
- Measures of Logistic Effects
  - ► R&M Parameters
  - ► Predictions and Allocations
  - ► Goals and Thresholds

DoD READINESS AND SUPPORTABILITY OBJECTIVES

Dr. Webster's statement is most apropos for next-generation fighters, airlifters, transatmospheric vehicles, etc., that must operate in the 1990s time frame without the sanctuary of the main operating bases. One universal charateristic needed in all of these types of vehicles is maximum self-sufficiency to sustain high sortie generation rates under wartime conditions.

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SUPPORTABILITY (S) AND THE MISSION PROFILE

DESIGN PHASE	MISSION PHASES				
OPERATIONAL NEED OR MISSION IS ASSIGNED	AIRCRAFT IN ALERT OR STANDBY STATUS	MISSION IN PROGRESS	MISSION OBJECTIVE & RETURN TO DOL	DOL OPERATIONS • QUICK TURN-AROUNDS • QUICK CONFIGURATION CHANGES • SELF SUFFICIENT	DAY-TO-DAY ROUTINE MAINTENANCE
SYS SPEC DEFINES SUPPORTABILITY REQUIREMENTS FOR "INTENDED USE": OPERATIONAL SUITABILITY OPERATIONAL SUSTAINABILITY IN-FLIGHT SUSTAINABILITY READINESS AVAILABILITY R&M LOGISTICS LIFE CYCLE COSTS SURVIVABILITY MOBILITY/TRANSPORTABILITY	READINESS • BIT • ID • APU	IN-FLIGHT SUSTAINABILITY • RELIABILITY • REDUNDANCY	SURVIVABILITY • S CONSIDERATIONS FOR: - N. HARDNESS - LOW OBSERVABLES - BATTLE DAMAGE RESISTANCE	OPERATIONAL SUSTAINABILITY • MAINTAINABILITY • SERVICEABILITY MOBILITY/TRANSPORTABILITY FLEXIBILITY	AVAILABILITY

ELEMENTS OF SUPPORTABILITY

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SUPPORTABILITY (S) AND THE MISSION PROFILE FIGHTER

DESIGN PHASE

MISSION PHASES

OPERATIONAL NEED OR MISSION IS ASSIGNED	AIRCRAFT IN ALERT OR STANDBY STATUS	MISSION IN PROGRESS	MISSION OBJECTIVE & RETURN TO DOL	DOL OPERATIONS • QUICK TURN-AROUNDS • QUICK CONFIG-URATION CHANGES • SELF SUFFICIENT	DAY-TO-DAY ROUTINE MAINTENANCE
SYS SPEC DEFINES SUPPORTABILITY REQUIREMENTS FOR "INTENDED USE":	READINESS • BIT • ID • APU	IN-FLIGHT SUS-TAINABILITY • RELIABILITY • REDUNDANCY	SURVIVABILITY	OPERATIONAL SUSTAINABILITY MOBILITY/TRANS-PORTABILITY FLEXIBILITY	AVAILABILITY

OPERATIONAL SUITABILITY	AVAILABILITY
	R&M
OPERATIONAL SUSTAINABILITY	LOGISTICS LIFE CYCLE COSTS
IN-FLIGHT SUSTAINABILITY	SURVIVABILITY
READINESS	MOBILITY/TRANS-PORTABILITY

SORTIE GENERATION

ELEMENTS OF SUPPORTABILITY

DESIGN-FOR-SUPPORTABILITY BASELINE

The arrows that emanate from the MOB to the S element "availability" represent the support planning baseline that, together with the triad, has always driven the air vehicle designs to heavy dependence on the MOB. Even fighters have been driven to design for operations from the MOB in peacetime with an untenable mobility problem when warfighting from any base except the MOB.

The Air Force 2000 report, Rand Corp. research studies and official documents from WAL all substantiate the need for a change in the baseline from the MOB to a dispersed operating location (DOL) as represented by the arrows associated with the design-for-S baseline at the DOL. The problem with specifying the DOL as the baseline is that a DOL can be anywhere and not under Air Force control. The intent can be accomplished by specifying a bare-base COB (Collocated base). The definition of a bare-base COB for the intended use of warfighting in Europe/3rd World is a NATO site equipped with minimum essential facilities (MEF) and NATO-USAFE approved shelters with MOSS kits. This design-for-S baseline will require new design from a "clean sheet of paper" rather than a "warmed over" existing design to really achieve supportability inherent in the design.

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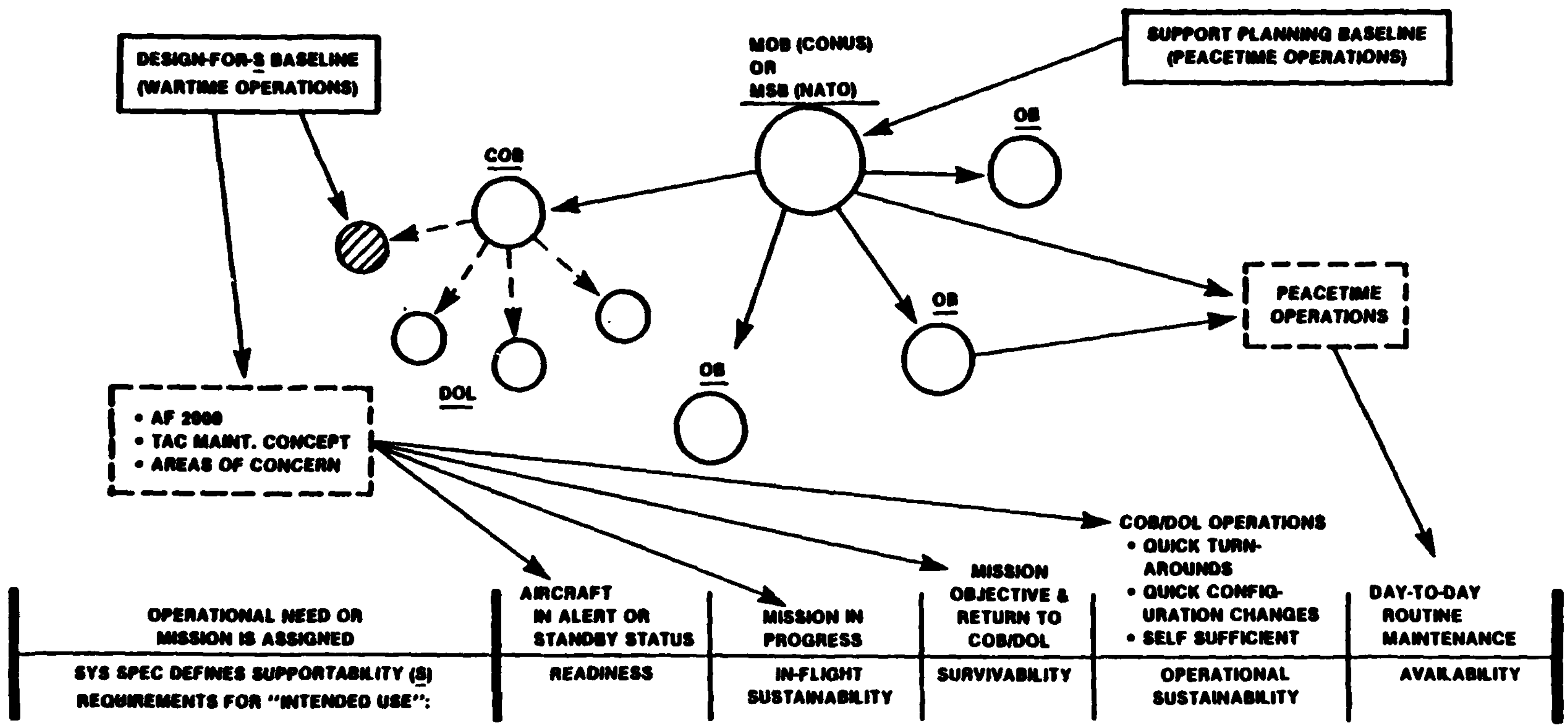
DESIGN-FOR-SUPPORTABILITY BASELINE

LEGEND

MOB — MAIN OPERATING BASE
MSB — MAIN SUPPORT BASE
OB — OPERATING BASE
COB — COLLOCATED BASE
DOL — DISPERSED OPERATING LOCATIONS



USE STUDY - LSA TASK 201

The use study is prerequisite to all other LSA analyses and therefore it should establish irrefutable logic to guide the design for $\underline{S}$. Design for $\underline{S}$ is defined as the degree that the air vehicle incorporates $\underline{S}$ design features/characteristics which provide operational suitability for intended use. Such logic is represented on this chart to derive $\underline{S}$ characteristics for the next-generation fighter. Maximum self-sufficiency is required to achieve the quick integrated combat turn and both characteristics are required to achieve sustained high sortie generation rate. Certain $\underline{S}$ design features are required to achieve these characteristics. For instance, on-board electrical/hydraulic/ pneumatic power generation features are required and an on-board oxygen generation system (OBOGS) is also required to achieve the degree of self-sufficiency needed to achieve the integrated combat turn.

The above logic can be computer programmed and taken even further. For instance, if an APU is the design solution for on-board power, then the fuel tank vents must be located to preclude fuel vapors being ignited by the APU. Programming such irrefutable logic is the first step toward artificial intelligence programming of $\underline{S}$.

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USE STUDY—LSA TASK 201

QUALITATIVE S DEFINITION: ...*DESIGN FEATURES/CHARACTERISTICS...THAT PROVIDE OPERATIONAL SUITABILITY...FOR INTENDED USE*

↓

INTENDED USE = WARFIGHTING IN EUROPE/3RD WORLD FROM COB/DOL

↓

DESIGN-FOR-S BASELINE = THE COB NEAR BARE-BASE AUSTERITY

↓

AIRCRAFT S CHARACTERISTICS ASSOCIATED WITH THE DESIGN-FOR-S BASELINE THAT PROVIDES OPERATIONAL SUITABILITY FOR THE INTENDED USE, E.G.:

- MAXIMUM SELF-SUFFICIENCY → S DESIGN FEATURES
- QUICK INTEGRATED COMBAT TURNS → S DESIGN FEATURES
- SUSTAINED HIGH SORTIE GENERATION RATE → S DESIGN FEATURES

MAXIMUM SELF-SUFFICIENCY

An air vehicle that is designed for self-sufficiency is somewhat free of dependency on things such as listed by the bullets on the charts. Identification of the S̲ design features/solutions to the right of the arrows is an extension of the LSA Task 201 Use Study. Lockheed considers the identification and design tradeoff analysis of these S̲ design features/solutions to be a joint effort by *Design Engineering* and ILS organizations. Since the Design Engineering organization is responsible for S̲ specification language resulting from S̲ design characteristics/features/solutions, Lockheed's enhanced LSA approach includes Design Engineering in the beginning (Use Study) of the LSA process.

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MAXIMUM SELF-SUFFICIENCY
(SUPPORTS UNIT AUTONOMY)

FREEDOM FROM DEPENDENCY ON:

- FLIGHT LINE SE ⟶ APU, BOOTSTRAP TECHNIQUES, SELF-TEST/DIAGNOSTICS, CONDITION MONITORING, INTEGRAL LADDERS, OBOGS
- HARD COPY MANUALS ⟶ AUTOMATED (ELECTRONIC) PUBS
- AVIONIC INTERMEDIATE SHOP ⟶ MODULE-LEVEL MAINTENANCE [PAVE PILLAR, MULTIPLEXING, VHSIC, VHSOC]
- HIGH SKILL LEVELS ⟶ DESIGN FOR "GENERALIST" TO DO ON-EQUIPMENT AND OFF-EQUIPMENT MAINTENANCE
- SUPPLY SUPPORT ⟶ HIGH RELIABILITY [FEWER SPARES] AND MOUNTING OF CERTAIN WRSK ITEMS IN CONFORMAL POD SAME AS IN AIRCRAFT

QUICK INTEGRATED COMBAT TURNS

Some top-level S design features that drive R & M to achieve the quick integrated combat turn are listed by the bullets. Like the previous charts, the items to the right of the arrows are sub-element S design features/solutions necessary to achieve the top-level S design features that drive R & M.

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QUICK INTEGRATED COMBAT TURNS

- **MAXIMUM SERVICEABILITY** → ELIMINATION OF YELLOW GEAR AND ARRANGEMENT/INSTALLATION OF EQUIPMENT TO ALLOW PARALLEL SERVICING
- **READY ACCESS** → ARRANGEMENT/INSTALLATION OF EQUIPMENT TO ALLOW INSPECTION, TEST AND EASE OF REPLACEMENT OF MODULES OR OTHER EQUIPMENT ON THE FLIGHT LINE
- **EASE OF TESTING AND TROUBLESHOOTING** → SELF-TEST (BIT, BITE), ON-BOARD BUILT-IN DIAGNOSTICS/HMS (HEALTH MONITORING SYSTEMS), CONDITION MONITORING FEATURES, AND AUTOMATED SYSTEMS READINESS CHECKS

SUPPORTABILITY (S) AND S RELATED DESIGN FACTORS [LSA TASK 205]

The purpose of placing the information from the two previous charts onto this chart and adding SDTRs from other sources is to emphasize that a great deal of S in design is involved to achieve the bottom line, sustained high sortie rate.

It is also noted that LSA Task 205, S and S related Design Factors, is where S design characteristics and associated S design features are documented.

Lockheed records and tracks all Air Force lessons learned items under CALLA (Computer-aided lessons learned analysis) which is a subset of KELSA.

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SUPPORTABILITY (S) AND S RELATED DESIGN FACTORS [LSA TASK 205]

AIRCRAFT CHARACTERISTICS AND ASSOCIATED S DESIGN FEATURES:

- MAXIMUM SELF-SUFFICIENCY, MINIMIZE OR ELIMINATE:
  - FLIGHT LINE SE → APU, BOOTSTRAP TECHNIQUES, SELF-TEST/DIAGNOSTICS, CONDITION MONITORING, INTEGRAL LADDERS, OBOGS
  - HARD COPY MANUALS → AUTOMATED (ELECTRONIC) PUBS
  - AVIONIC INTERMEDIATE SHOP → MODULE-LEVEL MAINTENANCE [PAVE PILLAR, MULTIPLEXING, VHSIC, VHSOC]
  - HIGH SKILL LEVELS → DESIGN FOR "GENERALIST" TO DO ON-EQUIPMENT AND OFF-EQUIPMENT MAINTENANCE
  - SUPPLY SUPPORT → HIGH RELIABILITY [FEWER SPARES] AND MOUNTING OF CERTAIN WRSK ITEMS IN CONFORMAL POD SAME AS IN AIRCRAFT
- QUICK INTEGRATED COMBAT TURNS → MAXIMUM SERVICEABILITY, READY ACCESS, AND AUTOMATED SYSTEM CHECKS, TESTS AND DIAGNOSTICS
- APPLICATION/EVALUATION OF AIR FORCE LESSONS LEARNED DRIVEN BY INTENDED USE AND RELATED OBJECTIVES LISTED ABOVE
  - SDTRs TRACKED BY CALLA AND TRADEOFF EVALUATED USING KELSA
  - TAILORED SPECIFICATION LANGUAGE FROM TRADE-OFF EVALUATIONS
- SUSTAINED HIGH SORTIE RATE = ALL OF ABOVE

COMPARATIVE ANALYSIS - LSA TASK 203

This chart notes that the usual baseline comparison system (BCS) is based on MMH/FH which has limited value. Lockheed's enhanced BCS gets down to design related data that is directly related to R & M and cost.

This chart flow is to indicate that the Lockheed use study results provide direction and focus with respect to evaluating the items listed under the technological opportunities block. The Lockheed enhanced LSA [ELSA] process includes evaluation of S design features as described by SDTRs.

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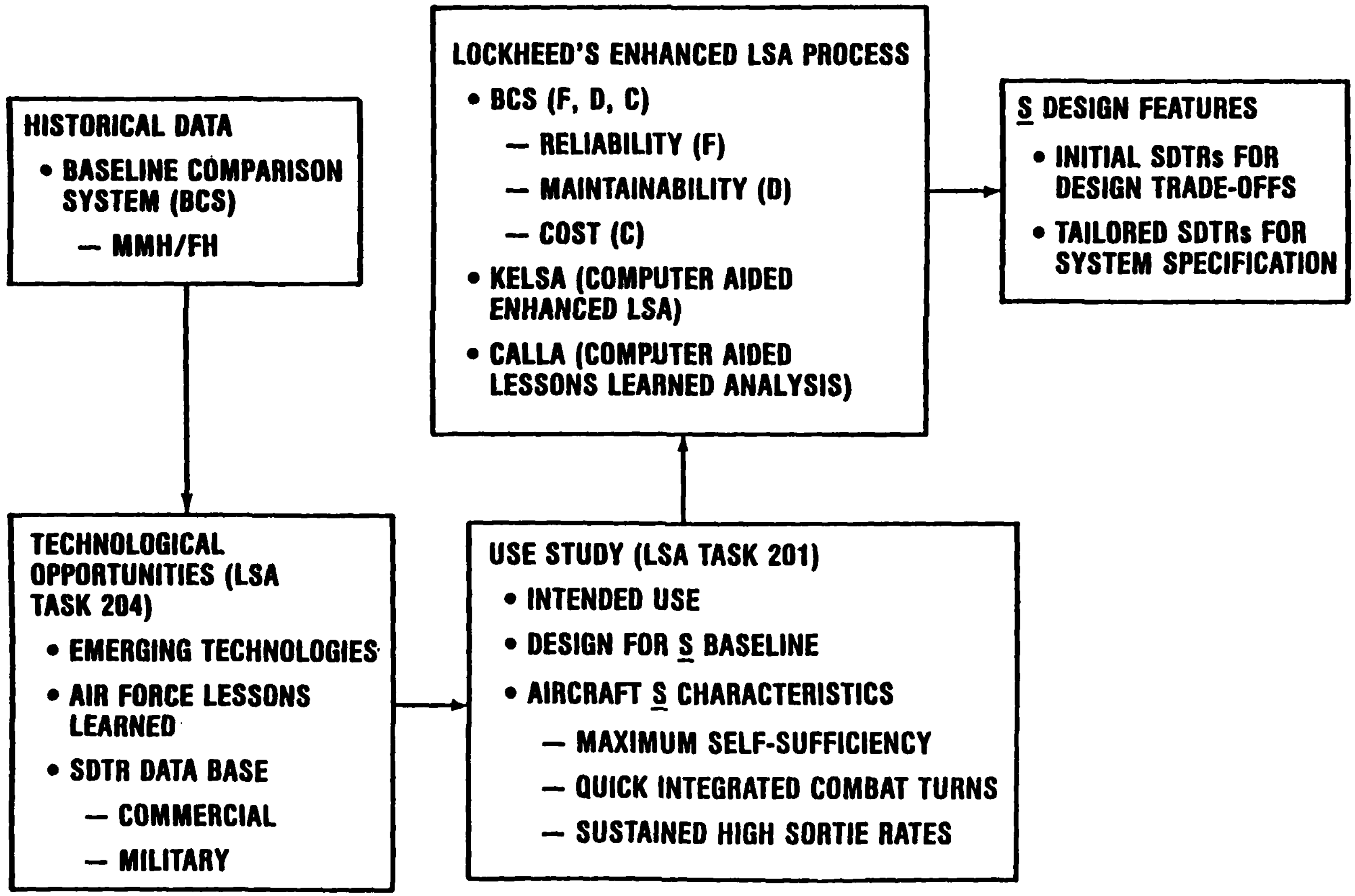
COMPARATIVE ANALYSIS—LSA TASK 203

COMPARATIVE ANALYSIS



SUPPORTABILITY DESIGN-TO REQUIREMENTS (SDTRs) PROCESSING TO DETAIL MODEL SPECIFICATIONS AND LSA "A" SHEETS

Although the documentation of alternatives and design trade-off analyses are documented under LSA Task 303, the Design Organization is responsible for both the design configuration and specification language describing the configuration. The tailored SDTRs resulting from the design tradeoffs are the basis for specification language for negotiation into the detail model specification.

The existing LSA "A" sheets contain only measures of logistic effects. For these to have validity, they must be design relatable. The Lockheed approach to add $ specification language to the LSA "A" sheets will add a valid design related basis for the measures of logistic effects. When the detail model specification and its $ distribution to the LSA "A" sheets have been competitively bid for contractor selection, only then will the program be ready for FSD.

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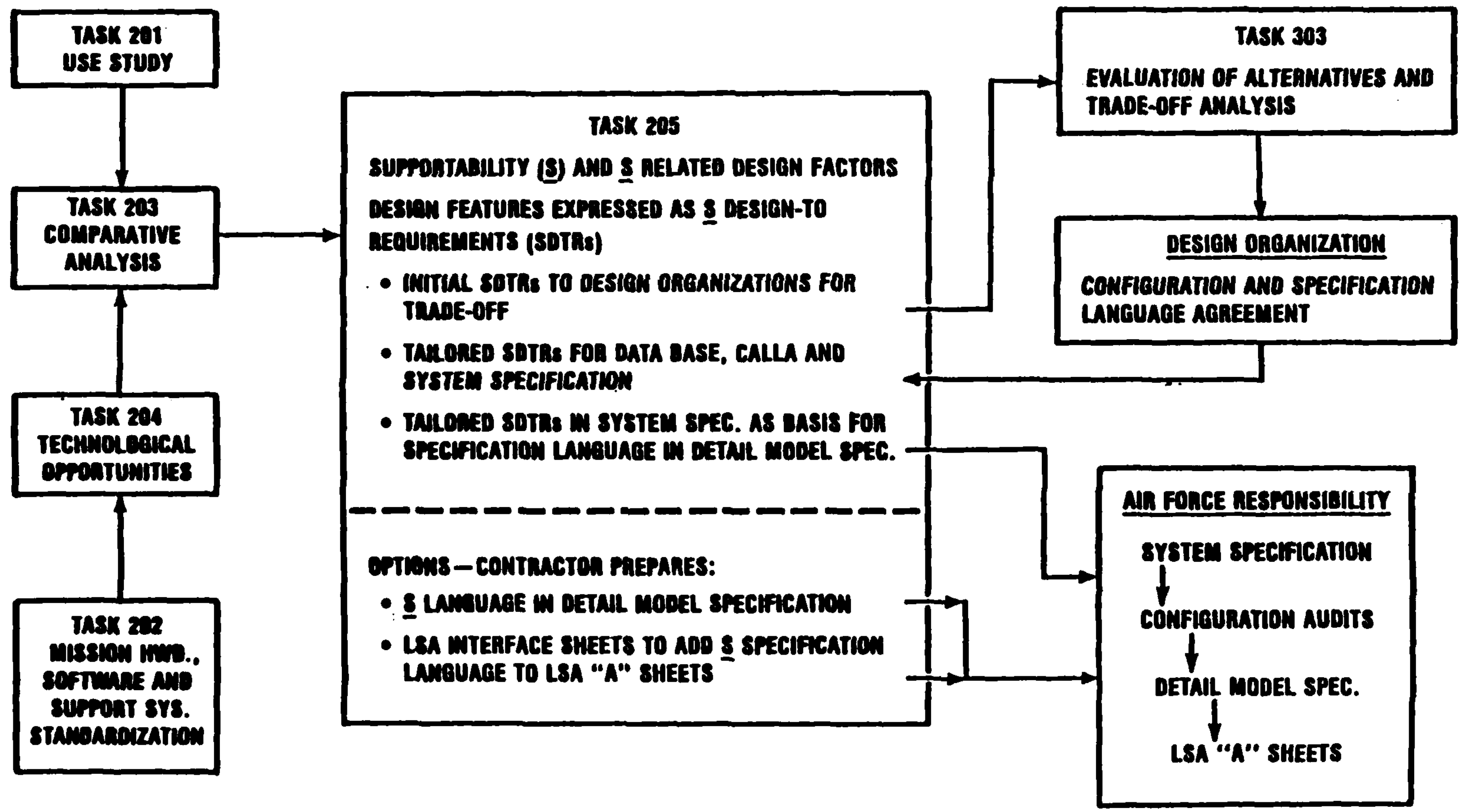
SUPPORTABILITY DESIGN-TO REQUIREMENTS (SDTRs) PROCESSING TO DETAIL MODEL SPECIFICATIONS AND LSA "A" SHEETS



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ACQUISITION PROCESS SUPPORTABILITY (S) RISK

PRIME RISK

The Military-Industrial Complex may not develop the S wherewithal techniques fast enough to keep pace with the flow and events of the acquisition process.

RECOMMENDATIONS

- Contractor S Engineers, in Engineering
  - ► Responsible for certain parts of LSA Tasks
  - ► Safeguard S "intended use" requirements in design by SDTRs
- Military S Engineers
  - ► System (Hyd., elect., avionics, etc.) maintenance experience
  - ► Technical approval of SDTRs
  - ► Part of S Configuration Audit Team
  - ► Technical altering of SDTRs to S specification language
  - ► Prepare and/or manage LSA "A" sheets

PLANNING FOR SUPPORTABILITY INPLEMENTATION

One objective of the design-for-supportability handbook is to develop guide instructions in the form of tutorial screen format for use with CAD/CAM and in automation of the ELSA. Both the Military and Industry organizations would be affected by adding S events, such as S configuration audits, to the flow and events of the acquisition process.

REPORT NO. 19

1. Creating the Logistics Information Model

A. FINDINGS

The CALS Technical Issues Subgroup feels that the critical importance of logistic data/information to prompt, accurate and effective decision making on weapon systems is strong justification for developing a general logistic information model. This model, therefore, is an important technical issue in itself but, more imporantly, it becomes the essential tool for identifying and characterizing other critical technical issues.

The Subgroup considered many other technical issues involving 1) development of standards; 2) data base systems; 3) networking procedures and 4) procurement practices, but concluded that these issues were being addressed by other CALS Subgroups or by the ongoing efforts of the DoD and industry. The concept of a logistics information model is a technical issue that is central to the interests of the entire logistics community.

The Subgroup recognizes that many data/information models exist (mostly diagrams or charts) which address various aspects of weapon development but none of these models addresses the specific logistic needs that require attention. These other models and several other sources of appropriate information constitute a valuable source of data/information for the proposed logistics model. Select such sources are listed at the end of this report.

Additional findings are reflected in the following recommendations, which are summarized and given time and funding estimates in the attached table.

B. RECOMMENDATIONS

Develop of the proposed logistic data/information model requi es at least the following steps:

1. A listing of all the logistic tasks or functions that must be performed on a generic weapon system. (Tasks to be drawn from MIL STD-1388 1&2; DoD directives 5000.39 & .40 and other sources.)

2. An identification of all the data/information sets that are required to perform the tasks listed in step 1 above.

3. Verification that steps 1 and 2 above are adequate to cover -

   a. Work on all of the defense weapon systems and sub-systems that are required for the national defense -- including foreign weapon sales and cooperative production programs

   b. All phases of each weapon system from its earliest concept through final disposition -- including any engineering changes to accommodate 1) new militarythreats; 2) error corrections; 3) new technology insertion or 4) modernization.

   c. All modes of defense product documentation or representation that are employed -- including 1) totally manual (hard copy) 2) mixed manual/computerized and 3) totally computerized modes as well as 4) vector or raster display.

   d. All types of data/information that will be required, including 1) graphics; 2) text; 3) tables; 4) mathematics; and 5) product models.

   e. The dynamic flow paths of the data/information from a typical repository through its various transformations, back to the same or to a different repository.

   f. Representative types and volumes of data/information required in the various tasks.

g. The most frequent used and/or the more critical data/information paths and operations versus those that are less frequently used or less critical (this will identify the so called "hot paths").

h. All restrictions placed on the involved data/information such as for 1) model integrity; 2) proprietary limits; 3) national security; or 4) export regulations.

i. The necessarily changing character of similarly labeled data/information as it proceeeds toward product maturity.

j. Assurance that the model and its components can be updated rapidly as the embedded technologies and the logistic procedures develop.

k. Assurance that a capability exists of handling or working around data/information related to the technologies employed in advanced defense products (VHSIC and optical technology).

4. Identifying the technical limitations of -- or the barriers to -- application of the model. Characterize the limitations and barriers in terms of their possible resolution by 1) coordination; 2) R&D; 3) contract statement; 4) directives; or 5) a combination of the above.

5. Survey the industrial and Service assessments of technologies that relate closely to the model (computer hardware, software and firmware; protocols, languages and data base systems).

6. Explore the early demonstration potential of the model -- especially by association of the model (or a section of the model) with appropriate ongoing weapon projects that might both utilize and share the benefits of such an exercise.

7. Set out and report on the criteria for assessing the measures of improved weapon effectiveness that result from use of the model.

8. Provide a basis for justifying the model by applying step 7 to real world problems. Report on the project to this stage.

9. Prepare a plan for implementing a practical pilot model including a report on the model's capabilities and limitations as it employs "available technology" in its application to typical weapon systems.

10. Demonstrate defined features of the pilot model and report on the objectives that were achieved 1) wholly; 2) partially; or 3) that were passed over.

11. Present a plan for the further application of the model.

The Subgroup further recommends that -

1. The steps listed above be coordinated thoroughly within the CALS Group and among the Services and the DoD agencies during processing of the project by the implementing office.

2. A single military Service be delegated the contract implementing responsibility for this project. Subject to the interests expressed by the individual Services and their ability to reach a concensus, the Subgroup recommends that the U.S. Navy be assigned this implementing responsibility, because of its operational use of such a wide variety of weapon systems.

3. The proposed 11 steps (or their revisions) be implemented in 2 phases including steps 1 thru 8 and steps 9 thru 11. These phases should be parts of a single contract, although with some modification, they might be two separate contracts.

The total project outlined on the previous page is estimated to require funding at the level of $250,000 to $300,000 and take 18 calendar months from date of contract authorization for its completion.

THE GENERAL LOGISTICS INFORMATION MODEL

Months after Authorization 0 3 6 9 12 15 18

Steps required for the Model

1. Prepare a generic list of logistics tasks
2. Prepare list of data/information sets required for step 1
3. Analyze and verify steps 1 and 2 so that the Model is able to:
   a. Work on all defense systems
   b. Work on all phases of a defense system
   c. Work on all modes of documentation
   d. Work on all types of data
   e. Identify dynamic flow paths of data within the Model
   f. Identify representative types and volumes of data handled
   g. Identify most frequently used data paths and data processes
   h. Accommodate administrative restrictions to data flows
   i. Accommodate data changes as a defense product matures
   j. Be updated rapidly for new technologies and procedures
   k. Accommodate data for advanced defense products.
4. Identify and characterize the Model's technical limitations
5. Survey industrial and Service technologies relating to the Model
6. Plan for early demonstration of key features of the Model
7. Set out criteria for assessing the benefits of the Model
8. Prepare justification of the Model (based on Step 7)
9. Plan for implementing a pilot Model (using available technology)
10. Demonstrate all or selected features of the Model
11. Plan for future application of the Model.

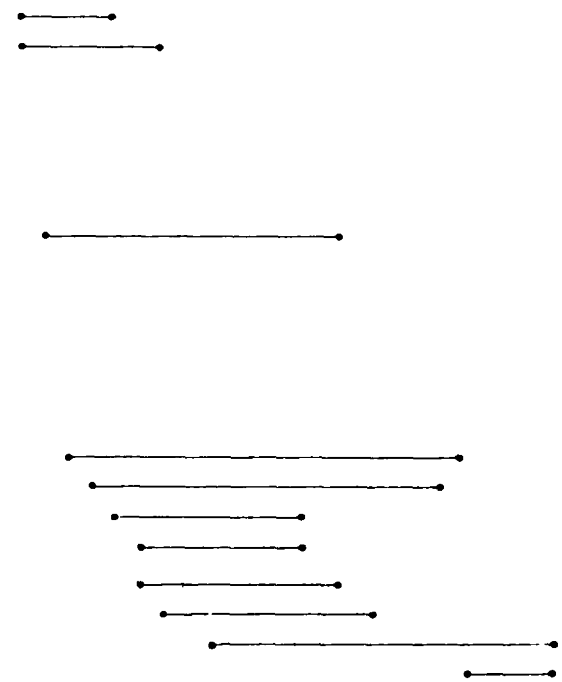


Figure 1. THE GENERAL LOGISTICS INFORMATION MODEL

SELECTED REFERENCES FOR THE LOGISTICS INFORMATION MODEL

1. Evolutionary Development of Computer Aided Support (CALS) - dated October 1, 1984 - by Darrell Cox (Rockwell)
2. Computer Aided Logistics Systems Supportability -- "A New Dimension in Design (3 layout sheets) - by Erich Hausner (Lockheed)
3. Acquisition Process for Major Defense Systems - a layout sheet dated July 1984 - by Booz-Allen & Hamilton, Inc., via Darrell Cox (Rockwell)
4. Acquisition Life Cycle Technical Activities by Mulak - a layout sheet via Darrell Cox (Rockwell)
5. Logistic Support Analysis Application Guidance -- MIL STD 1388 1A - a layout sheet dated March 1984 - by DARCOM
6. Flow of Information in a General Logistics Information Model - a layout sheet with comments, dated October 18, 1984 - by Darrell Cox (Rockwell) and George Beiser (IDA)

REPORT NO. 20

DEVELOPING DESIGN INFLUENCE ALGORITHMS FOR LOGISTICS

A. BASIC PREMISE

Existing R&M influences have not had sufficient design influence to assure fielded that systems exhibit high sortie generation rates or other measures of effectiveness.

Assume that the application of the developed algorithms/computerized LSA system takes place prior to PDR, and that these applications then keep pace with the design process. Phases of the application should be consistent (i.e., in levels of detail) with the acquisition process - from conception to O&S.

B. FINDINGS

1. The design of weapon systems occurs in a tightly compressed schedule environment in which the supportability influence must be exerted. The use of computers will enhance this process by integrating various design and supportability functions.
2. A variety of data bases exists which serve diverse functions. It is necessary to extract specific data elements for use by various disciplines from product concept formulation to customer feed-back.
3. Many models exist today which are used as peripheral tools to assist the designer and supportability engineer. These models impact various phases of the acquisition cycle and it is necessary to ascertain if the algorithms in these models can be integrated into a large scale model with mulit-purpose capability.
4. Logistics requirements can be extracted from the CAD/CAE that affect the generation of LSA sheets and cards. Furthermore, the design of support equipment and training devices can naturally follow from the defense product design information.

5. The design algorithms must be specifically tailored to address the intended use of the system; its operational environment; its integration with lessons learned and statistical data feedback.

C. RECOMMENDATIONS AND PROPOSED SCHEDULE

1. The object of the Design Influence Algorithm technical issue is to document the inadequacy of the logistics/design interface by referencing lessons learned, the less than adequate availability/reliability/maintainability, and to document by hind-sight what could have been done with adequate early information.
2. Industry and services have been aware of the problem for sometime and have already embarked on some forms of solution. These need to be reviewed to establish where overlaps or gaps exist, and to understand clearly the current capability.
3. Existing design algorithms must be identified and evaluated for applicability to the CALS effort. To effectively use the algorithms a data base must be found which contains adequate LSA information to design numerous widgets.
4. Where the existing algorithms do not meet the CALS requirements, new algorithms will have to be developed.
5. In the event that an existing data base contains insufficient LSA information, a new data base will have to be built with consideration being given to the needs of CALS.
6. For these algorithms to be tested properly, several different weapons systems (or subsystems) must be designed across the various design functions.

7. The demonstration of the use of the defined algorithms is seen as a relatively short span period. It will test the effectiveness to the designer for designing the various weapon systems with supportability considerations early in the design process.

8. Upon conception of the design product, the item will be placed in service at which time the predetermined measures of effectiveness (MOE) will be assessed. In the event the product exhibits an excursion of the selected parameter beyond the expected design range, original design algorithms will be rechecked to ascertain the discrepancy or oversight. As part of this algorithm validation it will be necessary to correlate the test environment with the operational environment.

9. After validation of the algorithm, the system must be installed at some location, used, updated, and finalized for use in the logistics community.

DESIGN INFLUENCE ALGORITHMS SCHEDULE

Mths from go-ahead

1. Document problems
2. Investigate existing programs
   - Industry
   - Service
3. Identify and evaluate existing algorithms and associated data bases
4. Develop additional algorithms to meet shortfall
5. Develop composite data base (if existing data bases are insufficient)
6. Identify products to be designed for demostation
7. Demonstrate the use of defined algorithms for candidate products
8. Validation of algorithms
9. Finalize and install system

REPORT NO. 21
DEVELOPING A LOGISTICS WORKSTATION

A. FINDINGS

The logistics workstation will be expected to support DoD logistic interests in such areas as maintainability, supportability, reliability, testability, human factors, spares & repairs for a weapon system in the same way that a computer aided design (CAD) computer supports the designer in the areas of aerodynamics, hydrodynamics, structures, hydraulics, electronics, mechanical and design engineering. The workstation is vital during the design process but it also is essential in sustaining the engineering/logistics activities throughout the total life cycle of the weapon system. The logistics workstation 1) has a common architecture; 2) is modular in design; 3) is configurable to the various logistics functions; and 4) is a desk-top hardware/software system that is capable of manipulating textural, graphical and numerical data. Such a workstation will have its own specialized logistic software which will, among other things, apply algorithms for tradeoff analyses and employ complex logistic rules checking to ensure a supportable design.

Basic Workstation Characteristics

- Hardware-software upward/downward compatability
- Workstation interfacing and communication
  (Note: provides for flexibility)
- Ability to exchange data among workstation vendors
  Assumption: Application Programs exist.

Workstation Benefits

- Improved logistic quality
- Improved logistic productivity

- Unification of common logistic functions
- Improved technical communication
- Cost saving
- Better/quicker management decisions
- More efficient operating/environment

Current Logistics Problems

- Lack of accessing data that has been previously created
- Data information disconnect (e.g., the inability to transfer data (bases) from Design to Manufacturing to Spare Parts Procurement)
- Inconsistency of data
- Lack of data transfer among developing areas
- Duplication of data/multiple entries of same data
- Diverse implementation and development (e.g., cannot exchange logistic models, and handle other technological advances, etc.)
- Lack of standard data exchange/protocol (cannot transfer data from one vendor's hardware application or software to another vendor's hardware application, and software

B. RECOMMENDATIONS

The CALS Technical Issues Subgroup recommends the following steps in support of a logistics workstation -

1. Document logistics functional requirements including the preparation of:
   a. Maintenance Plans
   b. Training manuals
   c. Technical Manuals, total document requirements less than 50 pages of memory.

2. Document workstation configuration requirements
   a. Word Processing
   b. 0-4 megabytes of memory
   c. Graphic terminals - 1000 x 1000 resolution

3. Survey industry systems and plans
   a. Ensure that industry is tune with our requirements -Are we under- or over-estimating our requirements

4. Configurations trade-off studies and characteristics analysis
   a. Narrow down our choices setting well defined parameters in which we are going to operate

5. Document justification of workstation (cost, R01, payoff)
   a. Is it a good or bad idea? It is cost effective?

6. Prepare Demonstration Plan
   What should be demonstrated?
   a. Evaluation plan/criteria for judging acceptance of demonstration, e.g., response time, ease of use, availability of minimum level of software, expansion capability, etc.

7. Workstation demonstration
   a. One or more vendors demonstrating their proposed workstations capabilities (e.g., carrying out the Demo Plan)

8. Analysis and evaluation of demonstration

9. Document and publish demonstration findings

10. Recommendation: CALS workstation specification
    Description, constraints,...

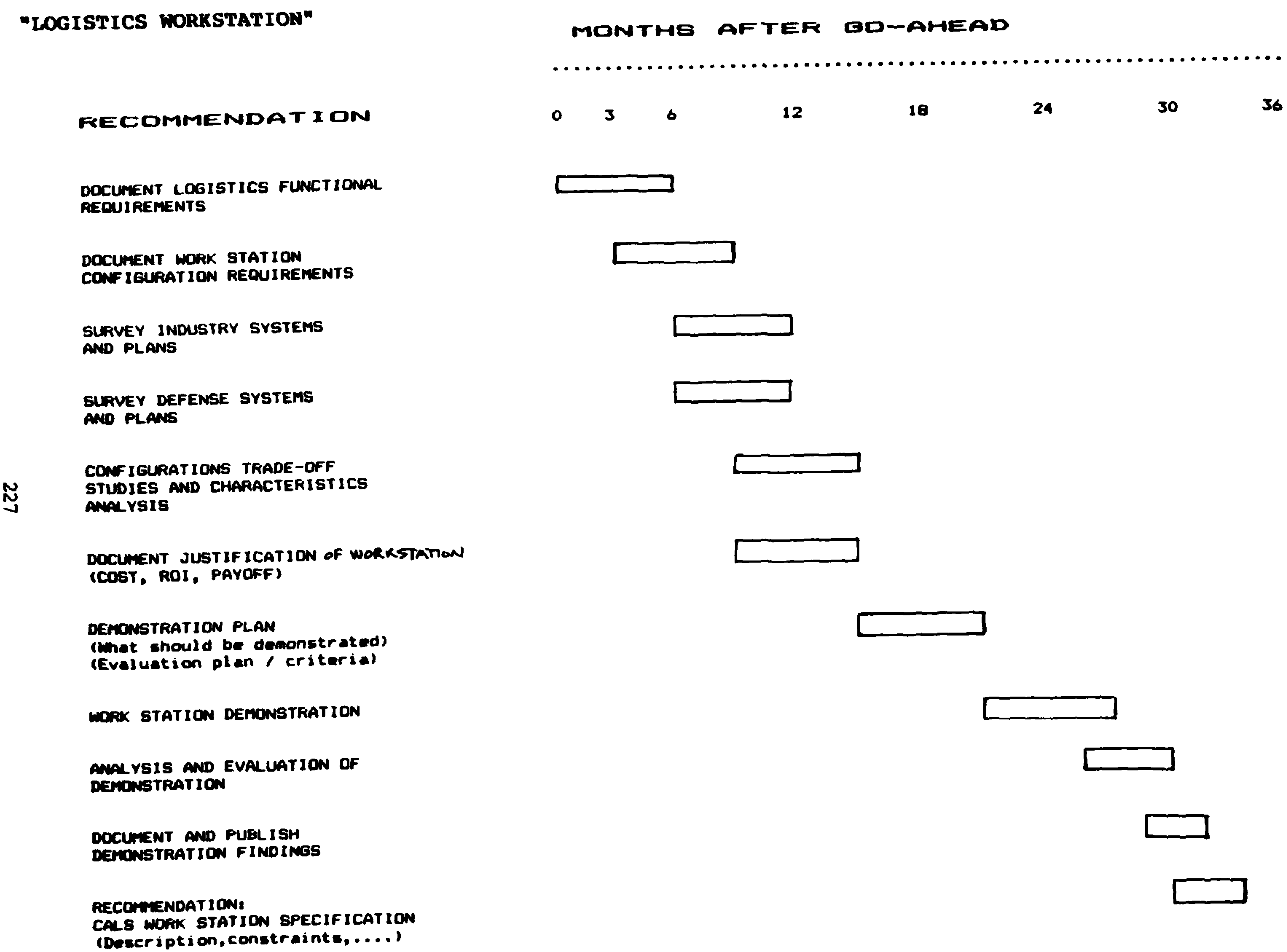


Figure 1. LOGISTICS WORKSTATION

REPORT NO. 22

DEVELOP A KERNEL LOGISTICS SYSTEM

A. DEFINITION: Kernel Logistics Information System is a system that allows computer automation to be deployed into highly distributed data systems.

B. TASKS

1. Make PCASS (Parts Control Automated Support System) available to industry.
2. Develop Federal Catalog. Utilize and enhance available catalog to improve characterization of existing inventory for preliminary design support.
3. Develop digital description of weapon system which would provide digital equivalent to current or existing engineering/logistic products.
4. Study logistic activity for developing the documentation processes:
   - develop data directory
   - augment field reporting system
5. Develop data bases which will support preliminary design selection
   - develop logistic basis which will provide intelligence for such design
   - emphasize relational logistic functions
6. Study impact of data used on DoD effectiveness
7. Study managerial aspects of non-digital data in transition period
8. Evaluate data protection technologies
   a. Severe environment: EMP, fire or crises
   b. Aging, archival preservation

c. Access control and integrity, reliability

d. Redundancy

9. Evaluate data obsolesence and relevancy
   - configuration history
   - audit trails/traceability

10. Define storage sizing strategy
   - local high density storage, mass storage systems
   - access protocol

11. Define Logistics Communication Network

12. Perform Productivity Study. Define potential impact on existing logistic systems.

13. Conduct cost-benefit analysis. Define minimum funding profile.

14. Develop specification for a Kernel System on two levels:
   - system level with emphasis on regulations and acquisition philosophy
   - implementation level
   - distinguish two lines: system itself and environment for the system

15. Study users' information requirements
   - managerial/hierarchical approach

Action Items:

1. Identify sources of data essential to CALS. (The fact is that DoD does not identify all its sources.) Identify requirements for generation of data and needs for maintenance of data.
2. Develop a new field reporting system that will take advantage of the new concepts.

Demonstration:

1. Demonstrate PCASS across DoD system functions in supporting preliminary design.
2. Demonstrate the new field reporting system on current weapon support system.

TIME SCALE

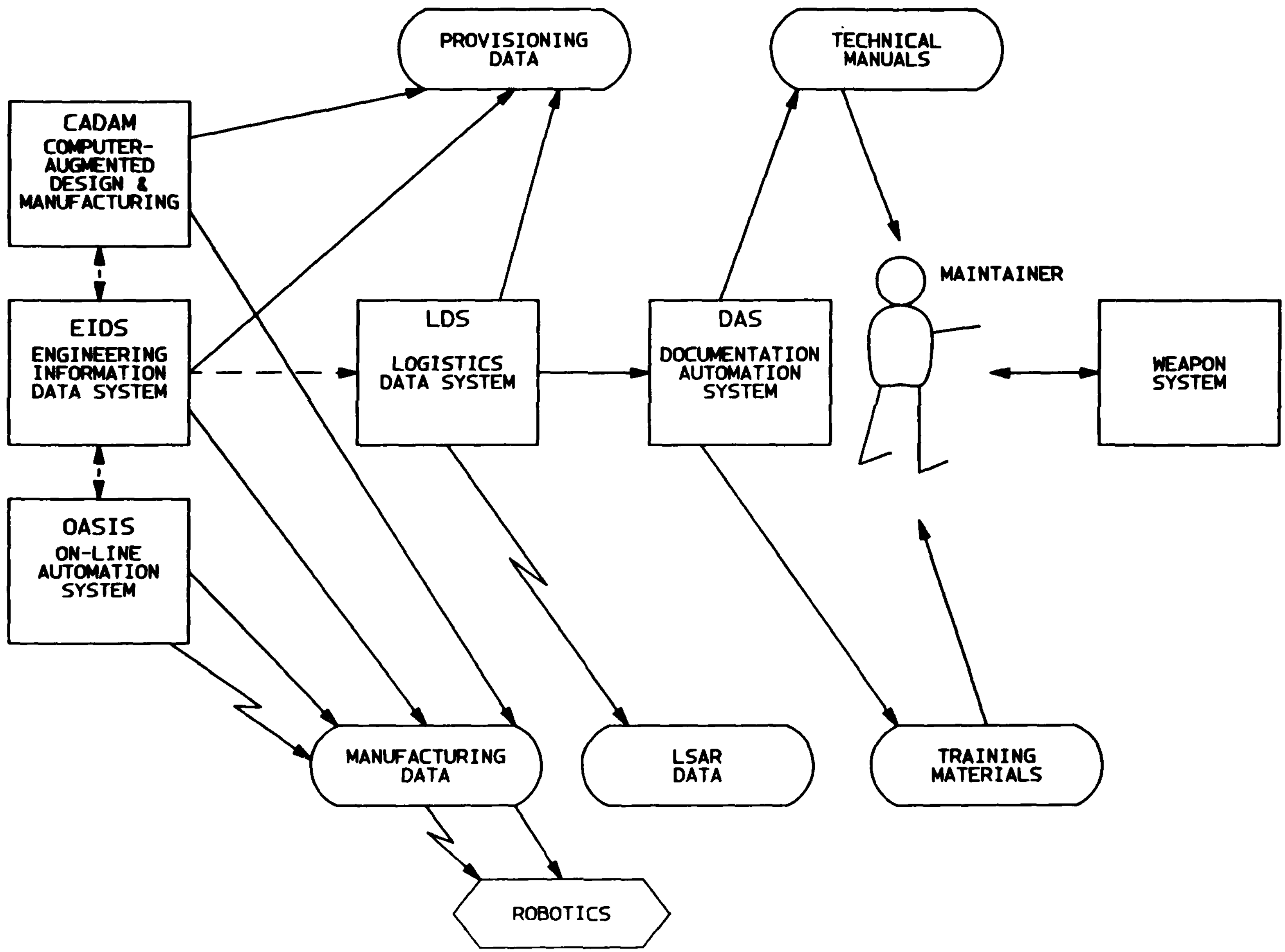
SUBJECT	85	86	87	88	89	90	91	92	93	94
	FY									
1. Getting digital data into Govt.	X	X								
2. Funding	X	X								
3. Studies										
- to develop logistic document process	X	X								
- PCASS, federal catalog	X	X								
4. Develop preliminary specification	X	X	X	X	X					
5. Validation						X	X	X	X	X

ASSUMPTION: Each study when started can be completed within 2 years after authorization.

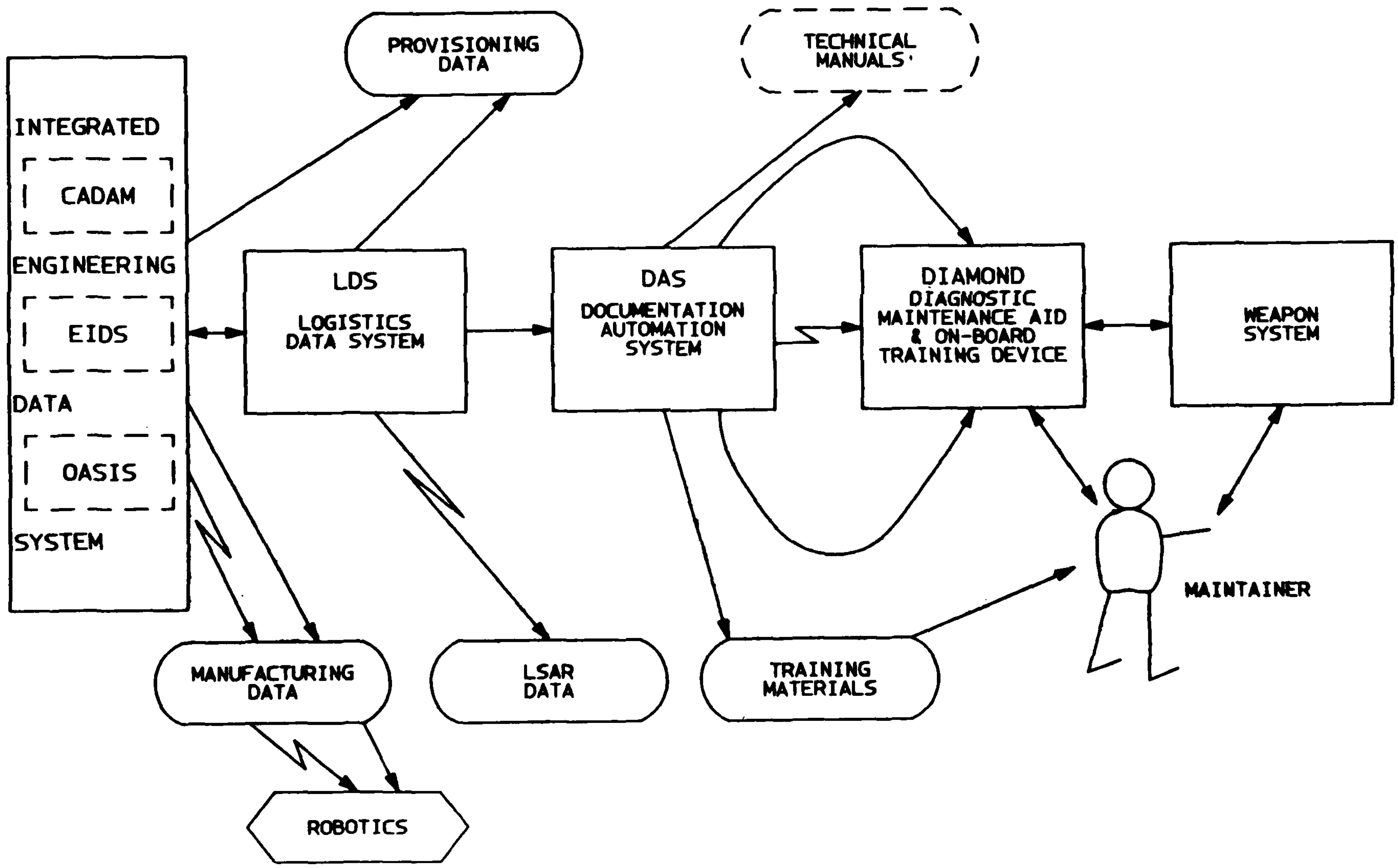
Initiatives In Automated Technical Information

IBM Federal Systems Division
Manassas, Virginia 22110

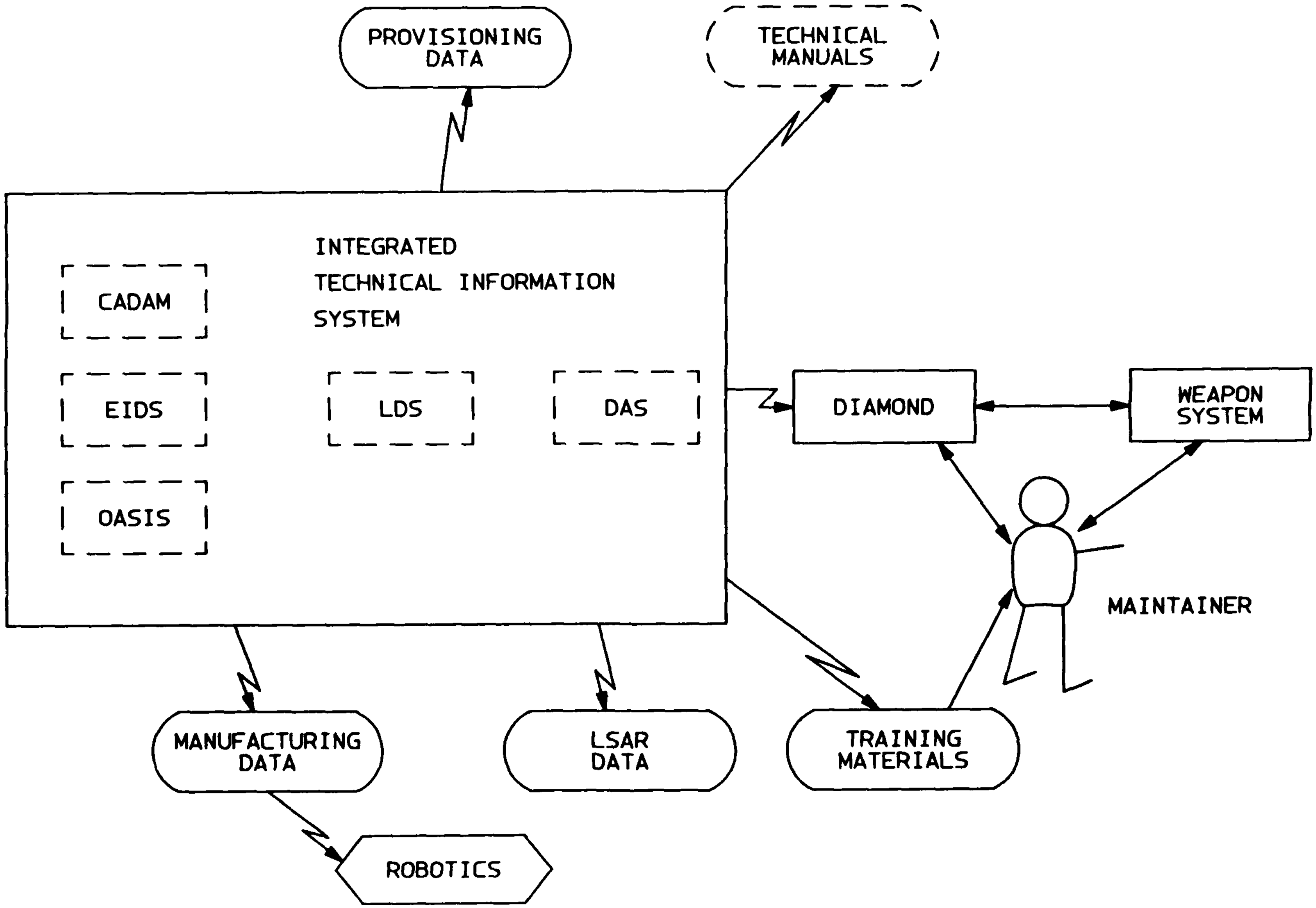
IBM MANASSAS LOGISTICS AUTOMATION -"TODAY"



IBM MANASSAS LOGISTICS AUTOMATION - "TOMORROW"



IBM MANASSAS LOGISTICS AUTOMATION - BEYOND "TOMORROW"



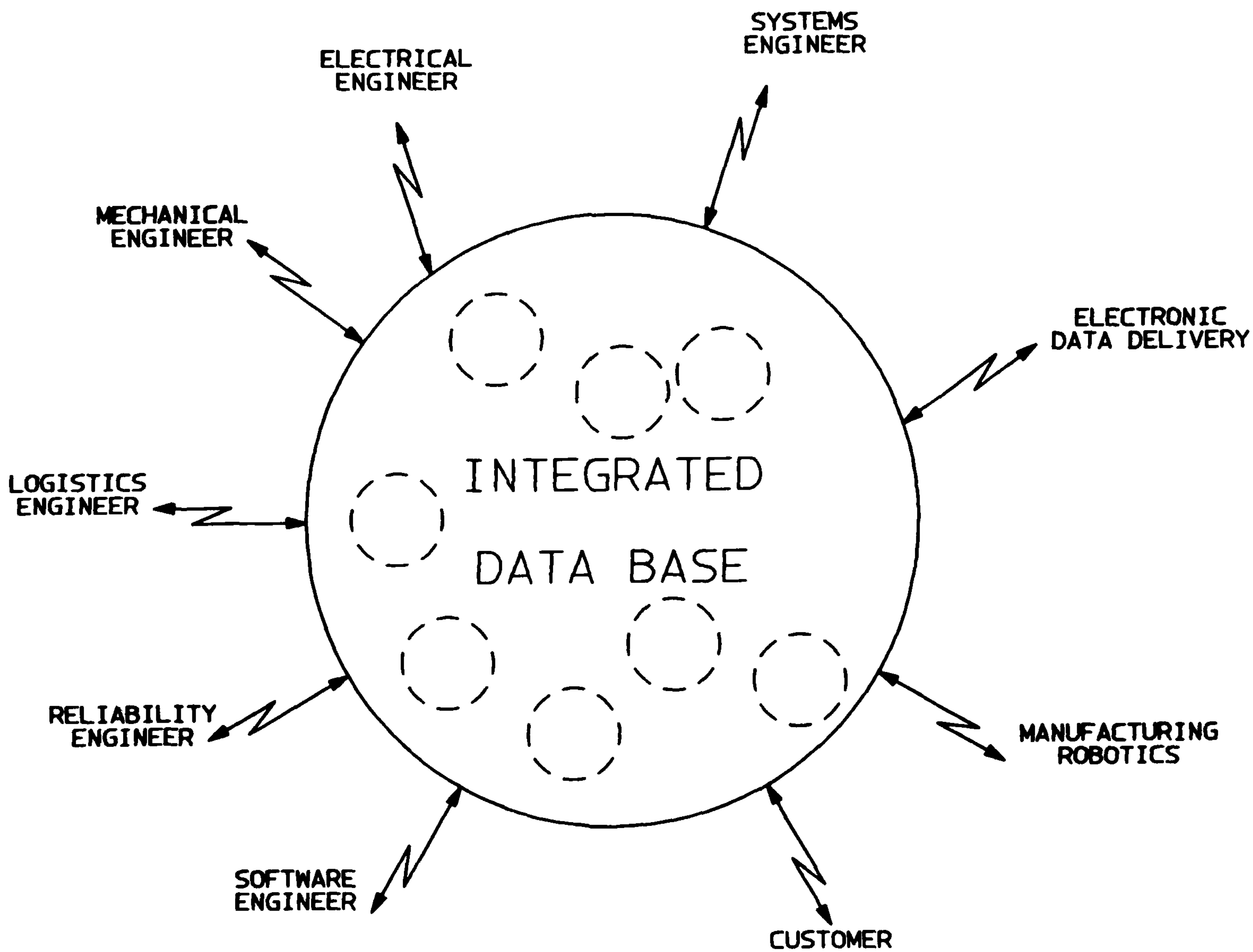
IBM MANASSAS OUTLOOK

Prepare for DoD & Industry Trends

- Electronic Transfer/Delivery
- Networking Among Data Bases
- Interface Standards

0184 0944

AUTOMATED TECHNICAL INFORMATION CONCEPT



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